BASIC MEDICAL SCIENCES FOR TECHNICIANS

ANATOMY

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MEDICAL LABORATORY TECHNIQUES FOR ROUTINE DIAGNOSTIC TESTS

Volume II (Part 1)

G. GURU
Project Coordinator

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FOREWORD

The programme of vocationalization of higher secondary education has been accepted by the country as it holds forth great promise for linking education with the productivity and economic development of the country by providing education for better employability of the youth.

In view of the importance of the programme the NCERT is making an all out effort to provide academic support to the implementing agencies in the States. One of the major contributions of NCERT is in the field of curriculum development and in the development of model instructional materials. The materials are developed through workshops in which experts, subject specialists, employers' representatives, curriculum framers and teachers of the vocational course are involved.

The present volume on **Anatomy** is one of the series on "Medical Laboratory Techniques for routine diagnostic tests" and is meant for the students of Medical Laboratory Technician course. It is being published for wider dissemination amongst students and teachers throughout the country. I hope that they will find the volume useful.

I am grateful to those who have contributed to the development of this volume. I must acknowledge also the immense interest taken by Prof. A.K. Mishra, Head, Department of Vocationalization of Education in inspiring his colleagues in their endeavours to develop instructional materials. Shri G. Guru, Reader, functioned as the Project Coordinator for the development of this title. He has my appreciation and thanks for planning, designing and conducting the workshop, for technical editing and for seeing this title through the press.

Suggestions for improvement of this volume will be welcome.

P.L. MALHOTRA
Director
National Council of Educational
Research & Training.

New Delhi,
March, 1986

PREFACE

Ever since the introduction of vocationalization in our school system by several States and Union Territories in our country the paucity of appropriate instructional materials has been felt as one of the major constraints in implementation of the programme and a source of great hardship to pupils opting for vocational studies at the higher secondary stage.

The Department of Vocationalization of Education of the National Council of Educational Research & Training, New Delhi has started a modest programme of developing instructional materials of diverse types to fill up this void in all major areas of vocational education. The task is too gignatic to be completed by any single agency but the model materials being developed by us might provide guidance and impetus to the authors and agencies desiring to contribute in this area. These are based on the national guidelines developed by a working group of experts constituted by NCERT.

The present volume is on **Anatomy** and is meant for the pupils and the teachers of Medical Laboratory Technician. Vocation being offered in a number of States and Union Territories. It contains basic medical science in anatomy required for a Laboratory technician. It is hoped that the users will find it immensely useful.

The material was developed during the workshop held in Dr. T.M.A. Pai Research Centre, Manipal. The present version was finalised after incorporating suggestions and comments by experts. The names of the contributors/reviewers are mentioned elsewhere and their contributions are admirably acknowledged. Shri G. Guru, Reader and Coordinator of this Project, Department of Vocationalization of Education, deserves special thanks for bringing the manual in the present from. The assistance of all in the Dr. T.M.A. Research Centre Manipal, especially of Dr. A. Krishna Rao,

Dean, Kasturba Medical College, Manipal and that of the Department of Vocationalization of Education, are also thankfully acknowledged.

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March, 1986.

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Prof. P. Jacob Abraham

Prof. B.B. Rath

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Shri S.M. Bhatt

GANDHIJI'S TALISMAN

"I will give you a talisman. Whenever you are in doubt or when the self becomes too much with you, apply the following test :

Recall the face of the poorest and the weakest man whom you may have seen and ask yourself if the step you contemplate is going to be of any use to him. Will he gain anything by it ? Will it restore him to a control over his own life and destiny ? In other words, will it lead to Swaraj for the hungry and spiritually starving millions ?

Then you will find your doubts and your self melting away."

M.K. Gandhi

CONTENTS

1. Anatomy and its Scope

1.1. Definition

Anatomy is the science which deals with the study of form and structure of any animal. When this study relates to human body we call it human anatomy. The term itself is derived from the word *anatome,* cutting up, referring to the method by which the knowledge of the subject is usually achieved. The subject deals with the parts of the individual and can be demonstrated to the naked eye by various methods of dissection.

1.2. Scope of Anatomy

Anatomy is one of the important basic sciences in the medical fields. When a disease occurs it may be associated with the alteration in the shape and size of particular organs. This may in turn displace the neighbouring organs. Thus the Technician must at least know the parts of the body, site of important organs, their approximate size, shape and structure. Likewise knowledge of location of certain important blood vessels is of utmost value in recording the pulse, blood transfusion or intravenous injections. The organs and tissues may be studied as they lie in relationship with one another in different regions of the body-constituting regional anatomy. Various structures may be studied as part of a system which is called systemic anatomy. Practical value of the knowledge acquired by dissection or seeing the dissected cadaver can be greately enhanced by frequent reference to the living body and identification of those structures, again which are susceptible to examination through the skin. This aspect is termed surface anatomy. When a disease occurs it is often found associated with structural changes also. When drugs are administered they again tend to come to normal. Structure and structural changes can be studied under microscope. This branch is histology. Additional information on the structure of living body can be obtained with the aid of radiological anatomy.

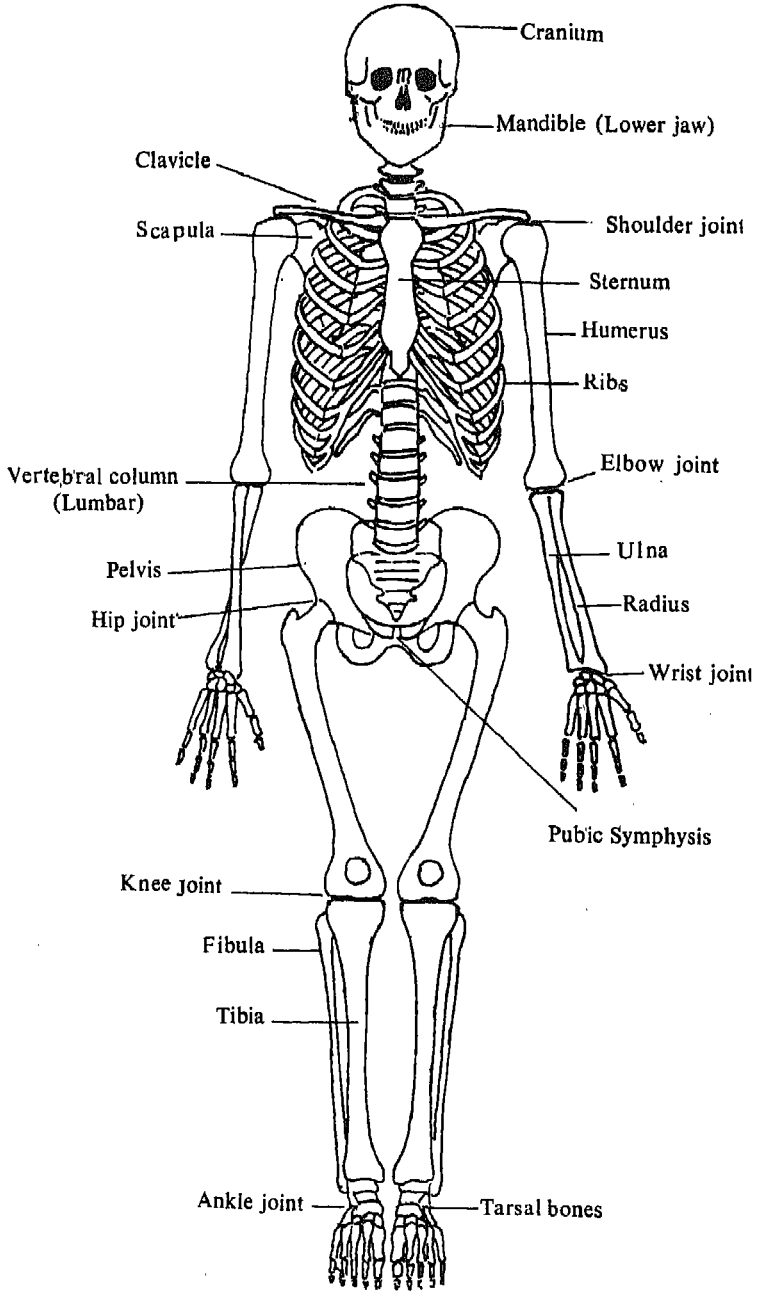

FIG. 1. SKELETON OF MAN

2. Introductory Anatomical Terms and Anatomical Position

The human body is supported by skeletal system which are joined by fibrous structures called ligaments to form joints. The joints are moved by muscles. Skeletal system conconsists of bones and cartilages. It consists of 1) axial skeleton-skeleton of head, neck and trunk; 2) appendicular skeleton-skeleton of the limbs. In the trunk, posteriorly there is vertebral column, anteriorly is the sternum and on either side are ribs and costal cartilages. Between the ribs are intercostal spaces. There are 12 ribs on each side and 11 intercostal spaces. Sternum in front consists of an upper part-manubrium, middle part-body and a lower part called xiphoid process. Joint between manubrium and body of the sternum is called sternal angle which is an important landmark on the surface. This is in line with 2nd costal cartilage and rib. So from this level succeeding ribs can be counted. Costal margin is formed by cartilages of the 7th, 8th, 9th and 10th ribs and it can be felt on the surface. (Fig. 1)

The human body is studied from erect position with the arms by the sides and palms of the hands facing forwards, the head erect and eyes looking straight in front. This is described as the anatomical position. Organs and structures of the body are described as they are situated in the anatomical position. Certain imaginary planes are used to describe the various structures. Median plane runs through the centre of the body. A structure lying nearer to the median plane of the body than another is said to be medial to that of other. Anterior means the front side and posterior means near the back. Superior is near the head side, opposite to that in inferior. Other terms will be described as and when it is necessary for particular structure or organ.

Pubic symphysis is the joint between the two hip bones anteriorly. Hip bones mainly form the skeleton of the pelvis. Above this pubic symphysis upto the costal margin, the lower part of trunk is called abdomen. In the anterior midline of the abdomen there is a depression corresponding to linea alba. Umbilicus lies on a level with

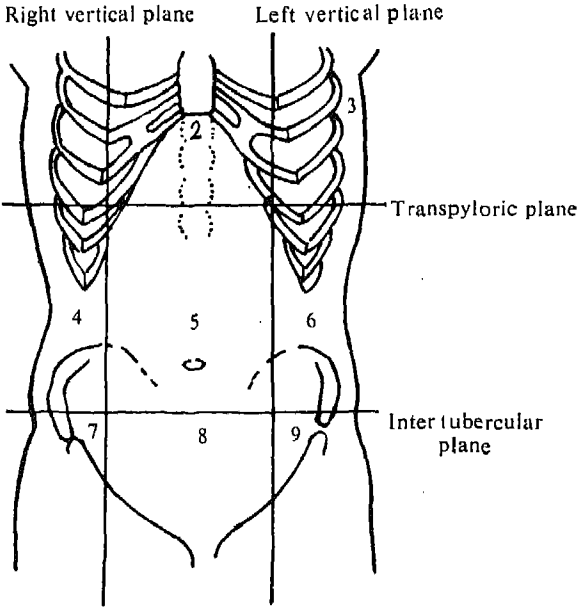

FIG. 2. ABDOMINAL AND PELVIC CAVITIES SHOWING REGIONS

the disc between third and fourth lumbar vertebrae.

To indicate the position of internal organs, on the anterior abdominal wall certain planes are represented which divide the abdomen into nine regions. Two vertical lines are right and left lateral planes corresponding to the middle of collar bones. Two horizontal lines-1) upper one drawn at the midpoint between upper border of manubrium and pubic symphysis is called transpyloric corresponding to the 1st lumbar vertebra; 2) lower horizontal line is called transtubercular plane corresponding to 5th lumbar vertebra. These planes divide the abdomen into 9 regions as shown in the diagram (Fig. 2 and 3).

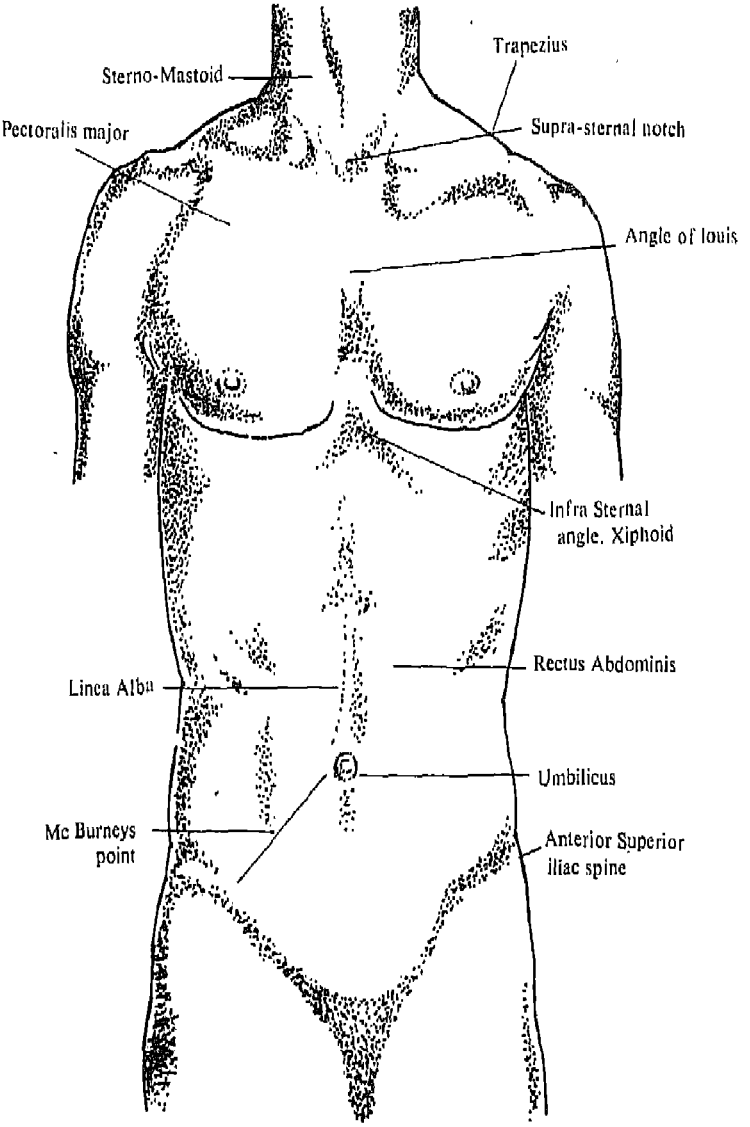

Fig. 3. ANTERIOR ASPECT OF THE TRUNK

3. The Cell and Basic Tissues

3.1. The Cell

Just like the buildings are built of bricks, our body is made of unit structures called cells. Cells are specialised to form various tissues and organs of the body. So it is necessary to know briefly about the structure of the cell.

The Animal Cell

A cell is a mass of living material enclosed by a wall called cell membrane. It has the following parts.

(1). Cell membrane: Forms the outer wall for the cell. Exchange of substances takes place between the protoplasm inside and tissue fluid outside the cell.

(2). Protoplasm: Is the mass of living substance inside the cell membrane. It consists of small globular and more solid portion called the Nucleus near the middle and fluid component called cytoplasm.

(3). Cytoplasm: Is a jelly like substance consisting chemically of proteins, lipoids, inorganic salts, water and cell inclusions. Cytoplasm presents the appearance of a net work called spongioplasm; the more fluid portion which occupies the meshes of the reticulum is called the hyaloplasm. The pigment granules, fat globules, watery fluid in vacuoles and glycogen present in the protoplasm constitute the paraplasm.

(4). Centrosome: Is a small spherical mass of protoplasm and lies near the nucleus. One or two minute particles called centrioles are present in its interior. These play an important part in cell division.

(5). Chondriosomes: Consist of minute particles of rods, granules or filaments called mitochondria. They are the store-houses of energy.

(6). Golgi bodies: Consists of a groups of canal like structures near the nucleus. Protein synthesised in the cell is concentrated or processed here for secretion.

(7). Endoplasmic reticulum: It is a network of membranous structure scattered throughout the cytoplasm. These are concerned with protein synthesis.

The Nucleus

It is a round or oval mass in the protoplasm. Usually four distinct parts may be differentiated in the nucleus.

(a) *Nuclear membrane* bounds the nucleus and seperates it from the cytoplasm.
(b) *Nucleoplasm* is the fluid component containing granules called chromation.
(c) *Nucleolus* is a highly refracting body in the nucleoplasm.
(d) *Chromatin granules,* when condensed, form rod like structures called *chromosomes.* These chromosomes carry the *genes* which carry heriditary characters of the individuals. There are 46 chromosomes in the human cell.

Function of the Cells

1. Protection.
2. Absorption.
3. Secretion.
4. Sensory reception.

During the process of growth and maintenance cells divide to form new generations. This process of reproduction mainly takes place in two ways in the human body.

(1). Mitosis: Here the cell divides into 2, each of which have the same number of chromosomes and other structures.

(2). Meiosis: The result of this type of division is 4 cells. This type of division takes place in germ cells and the resulting cells have only half the number of chromosomes.

For the details of these divisions and structure of the cell one can refer to larger text books.

3.2. Basic Tissues

Human body consists of billions of cells. They are derived from the single fertilized egg cell in the mother's womb. The fertilized egg cell divides and redivides and differentiates to form various tissues, organs and systems of the body. As development of the individual

proceeds, groups of cells become differentiated from one another and are built up in different patterns to form the tissues of the body, in which the constituent cells are immobilized. There are five widely distributed basic tissues which are built up, in varying proportions, to form the organs within the body, the body wall and the appendages of the body. These primary tissues are:

1. Epithelial tissue
2. Connective tissue
3. Sclerous tissue
4. Muscular tissue
5. Nervous tissue.

3.2.1. Epithelium: Consists of a layer of cells lying on a basement membrane made up of connective tissue. Epithelium covers the surface of the body or lines the interior of hollow organs. Epithelium with the subjacent connective tissue form a functional unit called a membrance. In some regions the surface of the membrane is lubricated by mucous. Such membranes are called mucous membranes. When the surface of the membrane is lubricated by serous fluid the membrane is called as serous membrane.e.g. pleura, pericardium and peritoneum.

Epithelium consisting of a single layer of cells is called simple epithelium. When it contains many layers it is called stratified epithelium and is protective in function. Simple epithelium is classified according to the shape of its cells as follows:

(a) Columnar epithelium—tall cells, secretory or absorptive in function;
(b) Cuboidal—short and broad cells;
(c) Squamous epithelium—flat and thin cell.

In stratified epithelium also these varieties occur. for eg:
stratified squamous,
stratified cuboidal,
stratified columnar.

In Urinary bladder and ureters there is another modified epithelium called transitional epithelium. It consists of cells of different shapes most important of which are piriform cells.

3.2.2. Connective tissue: Consists of fibres in a ground substance (cement). The fibres are of mainly three types:-

(a) Collagen fibres which give tensile strength,

(b) Elastic fibres which give elasticity and

(c) Retifular fibres.

Apart from these, the connective tissue contains different cell types like fibroblasts which produce the connective tissue fibres, plasma cells, macrophages, fat cells etc. Connective tissue exists in different densities in different parts of the body.

3.2.3. Sclerous tissue: Consists of bones and cartilages. Bone is hard, rigid and forms the most of the skeletal system of the body. Bones contain bone cells called osteocytes, fibrous tissue and inorganic salts, mainly phosphate of calcium. Bones subserve the following important functions:

1) Give support to the body.

2) Act as lever for the action of muscles.

3) Provide the sites of formation of blood cells.

4) Act as storehouses of calcium.

There are 206 bones in the body. These together constitute (1) axial skelaton forming an axial support to the body and (2) an appendicular skeleton supporting the limbs. These bones are joined by ligaments forming the joints. Interior of bones is filled by a soft tissue called bone marrow. This marrow is of yellow or red variety. Red marrow produces the blood cells. In the adult red marrow is present only in certain bones like sternum (breast bone), ribs, vertebrae etc. Sample of this marrow tissue can be taken by a canula introducing into the sternum and this proceedure is known as sternal puncture.

Vertebral column forming the main component of axial skeleton is made up of smaller segments called vertebrae. Above vertebral column is joined to the skelton of the head and face called skull. Skeleton of the limbs are also attached to the vertebral column on each side. There are in all 33 vertebrae which are classified regionwise from above downwards as:

Cervical — 7,

Thoracic — 12,

Lumbar — 5,

Sacral — 5 — all fused, and

Coccygeal — 4 — all fused.

In the middle of the back of the neck is a vertical depression called nuchal furrow. Its lower end presents a bony elevation produced by the spine of 7th cervical vertebra. This can be used as a landmark to count the spines at the lower levels. A horizontal line

corresponding to the highest point of iliac crest corresponds to 4th lumbar vertebra. This plane can be used to count the vertebrae from below.

3.2.4. Muscular tissue: Muscle is the contractile tissue which by its contraction results in various movements of the body like:

1) movements of different joints;
2) peristaltic movements, respiratory movements, uterine contraction etc.;
3) pumping of the heart.

There are three types of muscles:

1) Skeletal muscle: Here the muscle cells or fibres have many nuclei and show transverse striations. They are mostly voluntary. Each muscle is surrounded by a connective tissue sheath called epimysium. Within each muscle bundles of muscle fibres are surrounded by another sheath called perimysium. Within each bundle individual fibres are separated by connective tissue called endomysium. Skeletal muscle fibres are unbranched.

2) Cardiac muscles: Present only in the heart. It is involuntary. Its fibres are also striated but branched and they join with that of adjacent fibre. Each cell in the fibre has one nucleus.

3) Smooth muscle: It is involuntary. It forms the muscular wall of the organs in the body. Muscle fibre has a single nucleus and is in the centre. Fibres are spindle shaped.

Muscles are supplied by nerves which bring impulses for their contractions. Skeletal muscles are mostly supplied by somatic nerves and involuntary muscles are supplied by autonomic nerves.

3 2.5 Nervous tissue: Nervous tissue consists of neurons and connective tissue. Connective tissue of nervous system is called neuroglia. Neuron consist of cell body and its processes called nerve fibres. Nerve fibres are of two types—

a) Dendrites which carry the impulses to the cell body and
b) Axons which carry the impulses away from the cell body.

Nervous system consists of a central nervous system and peripheral nervous system. Central nervous system includes brain and spinal cord. Peripheral nervous system consists of extensions from the central nervous system and is further classified into somatic system supplying the body wall and autonomic nervous system which is involuntary supplying mostly the organs.

Central Nervous System: Brain is situated in a bony case called

cranium. It is surrounded by three protective coverings. From within outwards they are pia mater, arachnoid mater and dura mater. Between these three coverings there are two spaces:

1) Sub arachnoid space between arachnoid and pia maters.

2) Sub dural space between dura and arachnoid maters.

Sub arachnoid space is important because it contains larger blood vessels supplying the brain and a fluid called cerebrospinal fluid. Cerebrospinal fluid provides a floating medium for protection and partly gives nutrition.

Brain is continued down into the vertebral canal as the spinal cord as far as the level of lower border of 1st lumbar vertebra. Coverings of the brain also continued around the spinal cord as far as the level of lower border of 2nd cacral vertebra. Thus between the first lumbar and second sacral vertebrae spinal cord is absent. Here the sub arachnoid space is enlarged. So samples of cerebrospinal fluid can be taken from this region. Usually in the interval between 3rd and 4th lumbar vertebrae or between 4th and 5th lumbar vertebrae a canula is introduced in the posterior mid line to the subarachnoid space. If the cerebrospinal fluid flows 1 drop per second it is the normal pressure of C.S.F. If it flows out continuously that means C.S.F. pressure is low. This precedure of taking a sample of C.S.F. from this region is called lumbar punture.

There are 12 pairs of cranial nerves attached to the brain and 31 pairs of spinal nerves attached to the spinal cord. These spinal nerves are named according to the regions as follows: (Fig. 4.)

Cervical — 8
Thoracic — 12
Lumbar — 5
Sacral — 5
Coccygeal — 1

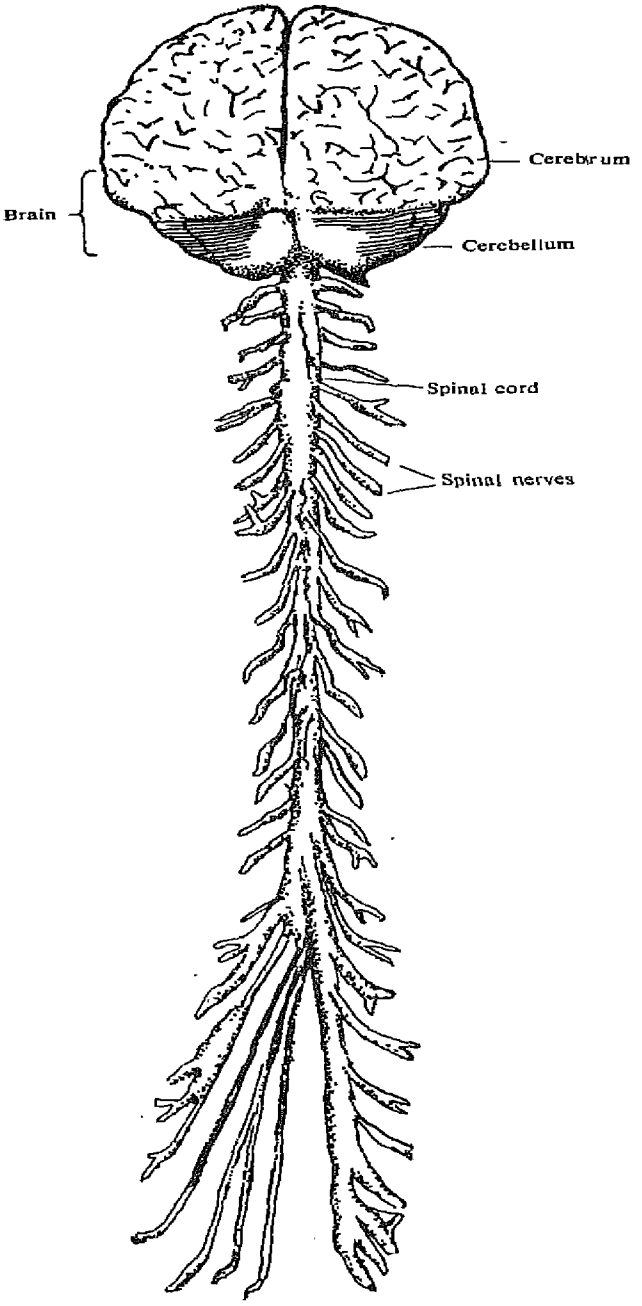

FIG. 4. BRAIN AND SPINAL CHORD

4. Limbs

4.1 Upper Limb

Upper limb articulates with the trunk through the shoulder girdle. Bones of the upper limb include:

(1) Clavicle or collar bone in front at the root of the neck.
(2) Scapula behind the upper part of the trunk.
(3) Humerus, the bone of the arm, which articulates with the scapula forming the shoulder joint. In this joint humerus may be displaced, more commonly forwards, constituting the forward dislocation.
(4) Radius and ulna in the forearm of which radius is lateral.
(5) 8 carpal bones and 5 metacarpal bones forming the skeleton of the wrist and palm.

The five fingers from lateral to medial side are thumb, index finger, middle, ring and little fingers. Each finger is supported by 3 phalanges except the thumb which has only 2 phalanges. The joint between the humerus and bones of the forearm is the elbow joint. Radius articulates with carpal bones forming the wrist joint.

The bony prominance on the top of the shoulder is produced by acromion process of scapula. It articulates with lateral end of clavicle. Fracture of the clavicle medial to its lateral 3rd interferes with the transmission of weight carried in the upper limb to the axial skeleton. Fracture of the humerus is common at its narrow constricted upper part called surgical neck of humerus. On the medial part of elbow joint there is a small bony projection called medial epicondyle of humerus. Posteriorly it is closely related to a nerve called ulnar nerve. Fracture of lower end of radius and its backward displacement is called cooly's fracture.

The smooth rounded elevation of the shoulder is due to a bulky muscle called deltoid. Intramuscular injections are given to this muscle about 2 inches below the acromion.

The main artery of the arm is the brachial artery. This artery is used for the recording of blood pressure measured by sphygmomanometer. This artery divides into radial and ulnar arteries in the

upper part of forearm. These arteries supply the forearm and hand. The arterial pulse rate is counted from the radial artery in the lower part of the forearm.

Nerves supplying the upper limb are lower 4 cervical nerves and 1st thoracic nerve mainly. These nerves form a network called brachial plexus. Large nerves to the upper limb arise from this plexus.

The superficial veins draining the upper limb are cephalic vein ascending on the lateral side and basilic vein ascending on the medial side of the limb. These veins arise from a venous network on the dorsum of the hand and are connected by median cubital vein in front of the elbow. The superficial veins are clinically much more important and are used for injections, transfusions, venae section and cardiac catheterization.

Muscle of the front of the upper limb are called flexor group. Muscles on the posterior aspect of the limb are called Extensors.

4.2 Lower Limb

Lower limb articulates with the lower part of the trunk through the pelvic girdle. Lower limb consists of a upper part called thigh, a middle part, the leg and a lower part called the foot. The hip bone forming the lateral wall of pelvis articulates with the thigh bone called the femur forming the hip joint. Close to this joint, the constricted part of femur called the neck of the femur is the usual site of fracture.

Leg has medial strong bone called tibia and a lateral bone called fibula. Tibia articulates with femur forming the knee joint.

Foot has 7 tarsal bones and five metatarsals. Toes are supported by 3 phalanges except the big toe which has only 2 phalanges. One of the tarsal bones called the talus articulates with the bones of the leg forming the ankle joint.

Above the back of the thigh, the smooth rounded elevation is called the buttock. Deep to this lies a bulky muscle called gluteus maximus. Upper lateral part of this muscle is the common site for intramuscular injections.

Muscles of the front of the thigh and leg are called extensor group of muscles and those on the back are called flexor group. In addition thigh has a medial group called adductor muscles; leg has a lateral group called peroneal muscles. Muscles of the front of the thigh are supplied by a nerve called femoral nerve and adductor muscles are supplied by obturator nerve. Rest of the muscles of the

thigh, leg and the foot are supplied by large nerve called sciatic nerve. Inferior aspect of the foot called the sole has a group of muscles which are also supplied by a terminal branch of sciatic nerve.

Main arterial supply to the lower limb is derived from femoral artery which descends infront of the thigh. In the upper part of the back of the leg this artery called as popleteal divides into 2 branches; one for the front and the other for the back of the leg and sole.

Two superficial veins arise from a venous network on the dorsum of the foot. One ascends on the medial side of leg and the thigh to open into the femoral vein accompanying the femoral artery in the upper part of the thigh. This is called the great saphenous vein. This constant vein infront of the medial malleolus is important in patients who require emergency blood transfusion . The other vein ascending on the lateral side of the leg is called short saphenous vein. It ends in a deep vein called popleteal vein on the back of the knee. Other veins are deep and accompany the arteries.

Nerves supplying the muscles conduct the impulses for their contraction. They are called motor nerves and their injury leads to paralysis of the muscles supplied by them. The nerves supplying the skin carry the sensations to the brain. They are called sensory nerves and their injury leads to anaesthesis.

5. Location, Size and Shape of Important Internal Organs of the Human Body.

5.1 Alimentary Canal and Associated Organs

Digestive system deals with the reception of food and with the preparation of it for assimilation by the body. Alimentary canal consists of following parts:

Mouth
Pharynx
Oesophagus
Stomach
Small and Large Intestine.

The entire alimentary canal is lined by mucous membrane. From the lips to the end of the oesophagus the lining epithelium is of stratified type. From the stomach to the anal canal it is of columnar type, and in the anal canal it is of stratified epithelium.

During the process of digestion food is broken down into simple substances which can be absorbed and used by the cells of the body tissues. These various changes in the food are brought about by the fermentation and/or activity of the enzymes contained in different digestive fluids.

5.1.1. The mouth: The mouth is an oval cavity at the beginning of alimentary canal. It consists of two parts—an outer vestibule and the inner cavity of the mouth. Vestibule is the space between the gums and teeth inside and the lips and cheeks outside. Cavity of the mouth is bounded at the sides by maxillary bones, the teeth and lower jaw. It communicates behind with the oral part of pharynx. Roof of the mouth is formed by palate, and the tongue lies in the floor. In the midline a fold of mucous membrane called frenulum linguae connects the tongue with the floor of the mouth. On each side of this lies the sublingual papilla which contains the opening of the submandibular salivary gland. Just outside this papilla lies the sub-

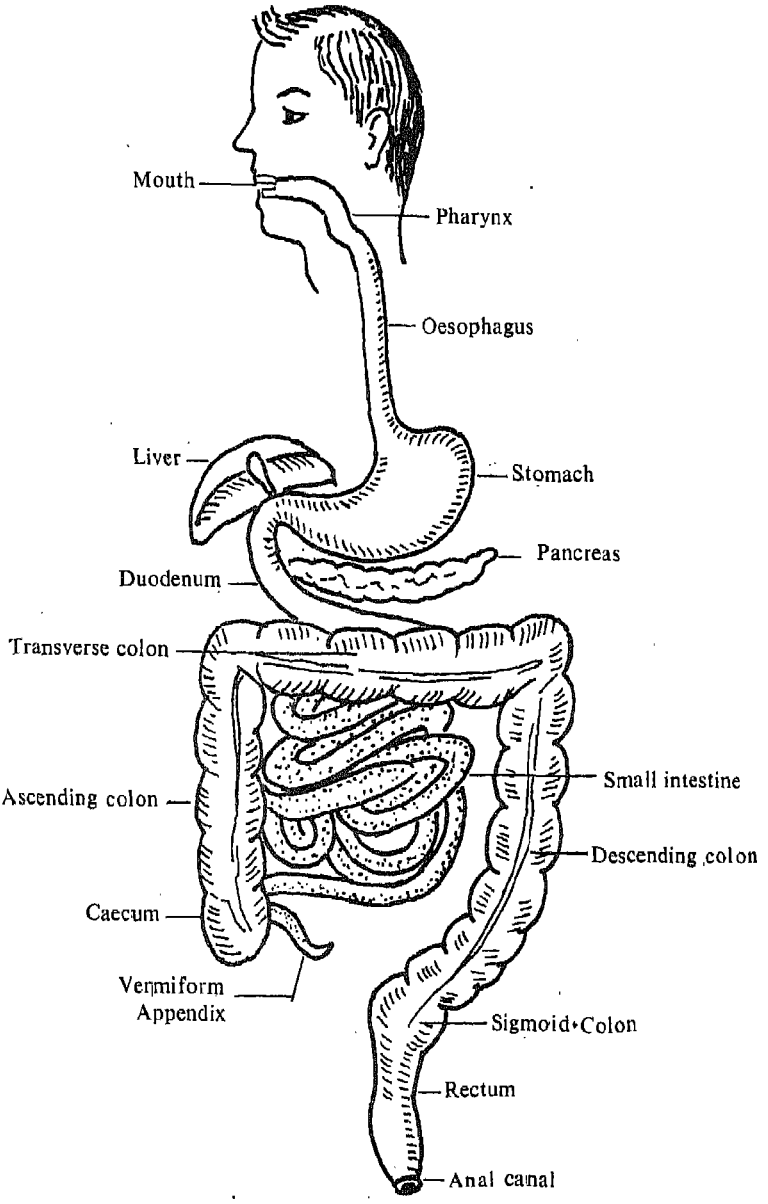

Fig. 5. ALIMENTARY CANAL

lingual fold where the tiny openings of the ducts of sublingual salivary gland lie. Mucous membrane of the mouth is very vascular. Beneath the mucous membrane lie tiny glands, which secrete mucous. It also contains numerous sensory nerve endings.

Lips are two fleshy folds which guard the orifice of the mouth. They are covered externally with skin and internally with mucous membrane. They contain the orbicularis oris muscle which closes the lips. Junction of upper and lower lips forms the angle of the mouth.

Palate consists of two parts, anterior hard palate formed by bone and posterior soft palate formed by fibrous tissue and muscles covered by mucous membrane. Its movements are controlled by its own muscles. From the middle of the soft palate a conical process called the uvula hangs down. Arching downwards and forwards from this are the pillars of the fauces between which lies the palatine tonsil.

Cheeks form the fleshy sides of the face and lined internally by mucous membrane and externally covered by skin. The muscle of the cheek is the buccinator. Teeth are used to cut the food in the mouth. In the child there are 20 temporary or milk teeth, ten in each jaw, named from the mid line on each side, two incisors, one canine, two molars. In the adult permanent teeth are 32—16 in each jaw—named from the centre, two incisors, one canine, two premolars, three molars. As a rule an infant cuts his first tooth at the age of six months, they are the central incisors of the lower jaw. A child of 12 months should have eight teeth, at the age of two years the child has the complete temporary set of teeth. Permanent teeth begin to replace milk teeth at about the age of 6 years.

A tooth possesses (a) crown, projecting beyond the gum, (b) root, surrounded by the gum and (c) neck, at the junction between the two. Mastication is the process of biting and grinding of food between the upper and lower teeth. Movements of the tongue and cheeks assist in mastication by manipulating the soft foods against hard palate and teeth. Movements of lower jaw are produced by the muscles of mastication. During the process of mastication food is mixed with the secretion of salivary glands in the mouth.

5.1.2. Salivary glands: These are the glands which secrete the saliva (Fig. 6.). They are composed of groups of sac-like alveoli, like the bunches of grapes which constitute the lobules of the gland. The whole gland consists of many such lobules. Small tubes called ducts arise from the alveoli, they carry the secretion from the alveoli and

unite to form larger ducts which pour the secretion into the mouth. Parotid **glands** are the largest salivary glands. They lie one on each side below and infront of the ear. Secretion of the parotid gland is carried by the parotid duct which opens on the oral surface of the cheek opposite the crown of upper 2nd molar tooth. Parotid gland is traversed by facial nerve, posterior facial vein and external carotid artery. Mumps is the infective or epidemic parotitis.

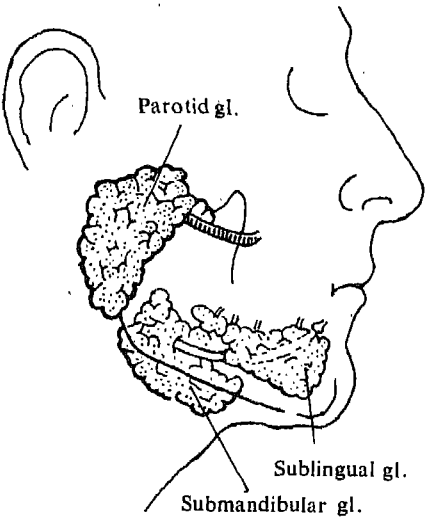

FIG.6. THE THREE ORAL (SALIVARY) GLANDS

Submandibular glands are the next largest glands. They lie one on each side beneath the lower jaw-bone, and they are about the size of a walnut. Their secretion is poured into the mouth through submandibular or wharton's duct which opens into the floor of the mouth.

Sublingual glands are the smallest pair. These lie beneath the mucous membrane of the floor of the mouth on each side of frenulum lingue. Their secretion is poured into the floor of the mouth through several small openings.

5.1.3. Pharynx and Oesophagus: Pharynx is musculomembranous passage lying behind the nose, mouth and larynx. It is about 5″ long. It consits of 3 **parts:**

1) Nasopharynx—behind the nose; this part is connected to the middle ear cavity by the Eustachian tube. Adenoids lie in the nasopharynx.
2) Oro-pharynx—behind the mouth; palatine tonsil lies in its lateral walls.
3) Laryngeal part of pharynx, is the lowest part, and lies behind the larynx.

There are 7 openings into the pharynx—two Eustachian tubes, two posterior nasal apertures from the nasal cavity, the mouth, larynx and oesophagus.

Structurally the wall of the pharynx consists of 3 coats, inner mucous coat, which is lined by ciliated columnar cells in the upper part, but stratified squamous epithelium in the lower part. Mucous coat is continuous with mucous membrane of nose, eustachian tube, mouth and oesophagus. Middle is the fibrous coat, outside which is muscular coat. Main muscles are the constrictor muscles which contract on receiving the food into the pharynx, and force it on to the oesophagus.

Tonsils are collections of lymphoid tissue in the lateral walls of oropharynx. They are permeated with blood vessels, lymph vessels and contain masses of lymphocytes. Surface of the tonsil is covered by mucous membrane continuous with that of oropharynx. Medial surface of the tonsil presents the opening of narrow recesses called crypts. Into these crypts mucous secreting glands deep to the tonsil pour their secretion. This mucous contains many lymphocytes. Thus the tonsils act as the first line of defence in infection spreading from the nose, mouth and throat. If they fail to resist this infection, tonsillitis or quinsy, a peritonsillar abscess may arise. After treating with antibiotics and local treatment, tonsillectomy may be considered.

Near the posterior nares and opening of the eustachian tube, the mucous membrane of nasopharynx also contains lymphoid tissue. Hypertrophy of this may obstruct the posterior nares. Collection of lymphoid tissue in the posterior wall of nasopharynx is called pharyngeal tonsil. Enlargement of these lymphoid tissues constitutes the enlarged adenoids. At the level of 6th cervical vertebra the lower end of pharynx becomes continuous with oesophagus.

Oesophagus is a muscular tube connecting the pharynx to the stomach. It is 9 to 10" long. In the neck it lies behind the trachea and infront of vertebral column. It passes through the thorax, pierces the diaphragm which is a musculo-tendinous partition between thoracic

and abdominal cavities and enters the abdomen to open into the stomach. Wall of the oesophagus consists of 1) an outer loose connective tissue coat, 2) a muscular coat composed of longitudinal and circular muscle fibres, 3) submucous coat and 4) an inner mucous coat lined by stratified squamous epithelium.

The remaining larger part of the alimentary canal is present in the abdomen.

5.1.4. Abdomen: The abdomen is the lower part of the trunk. Upper part of the trunk is the thorax. Abdominal cavity is bounded above by diaphragm and below by the pelvic brim. In front and at the sides it is bounded by abdominal muscles, iliac bones and the lower ribs, at the back by vertebral column and some muscles. Below the abdominal cavity is continuous with pelvic cavity.

Contents of the abdomen: The main organs that occupy the abdominal cavity are the greater part of alimentary canal, liver, pancreas, spleen, kidneys and the suprarenals.

Liver occupies upper and right part of the abdomen just beneath the diaphragm. It overlaps the stomach and first part of small intestine. Gall bladder lies on the under surface of the liver in a depression.

Pancreas lies across the posterior abdominal wall behind the stomach. The spleen lies near the tail of pancreas in the hypochondriac region below the diaphragm.

Kidneys and adrenals lie on each side of the vertebral column. From the kidneys ureters pass downwards through the abdomen.

Abdominal aorta, inferior vena cava, are the large blood vessels in the abdomen. In addition abdomen also contains lymph glands and vessels, nerves, peritoneum and fat.

5.1.5 Stomach: Stomach is the most dilatable portion of alimentary canal. It lies in the epigastric region, and partly in the left hypochondriac and umbilical regions. Stomach consists of an upper part called fundus which normally contains air. Below the fundus is the main body and a lower horizontal part, the pyloric portion. Its communication with the oesophagus is the cardiac orifice, and its opening into intestine is the pyloric orifice.

Stomach lies below the diaphragm, infront of pancreas, and is in contact with spleen on the left side of the fundus. (Fig. 7 & 8)

Structure: Stomach has 4 coats from outside to inside:

(1) Serous coat formed by peritoneal covering.

(2) Muscular coat consisting of inner circular and outer longitud-

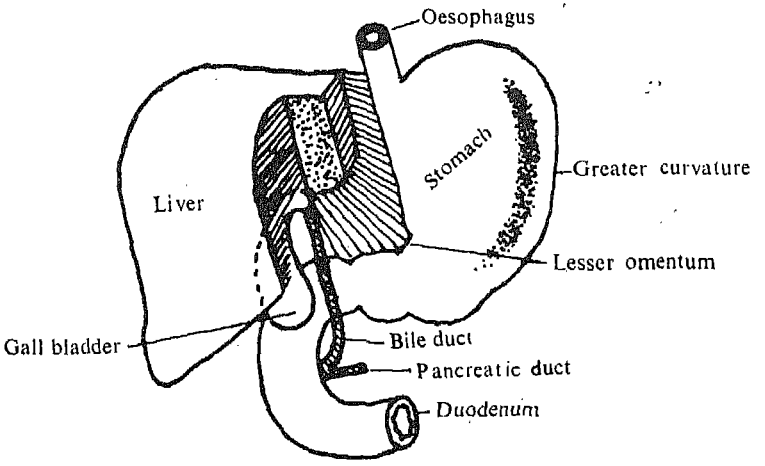

Fig.7 RELATION OF LIVER AND STOMACH

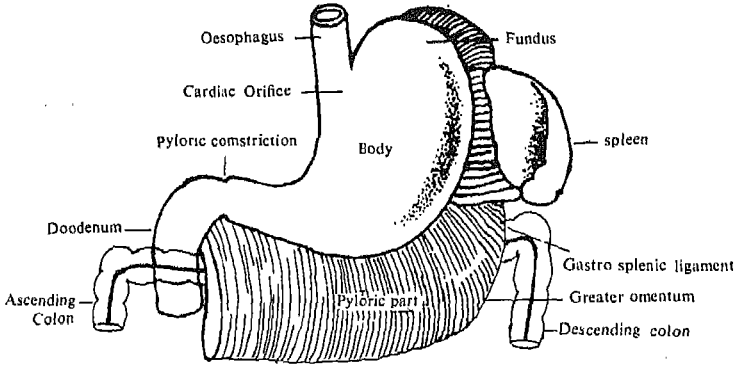

Fig. 8. STOMACH, SPLEEN WITH THEIR PERITONEAL ATTACHMENTS

inal layers of smooth muscle fibers. In the upper part there is an additional inner oblique coat.

(3) Submucous coat of areolar tissue containing blood vessels nerves and lymphatics.

(4) The mucous coat consisting of folds called rugae, which disappear when the stomach is distended.

Mucous membrane is lined by columnar epithelium. Gastric glands are also present with distinct peptic cells producing pepsino-

gen and oxyntic cells producing HCl. The pepsinogen is converted to pepsin by the action of HCl. Partly digestion of food takes place in the stomach.

Stomach has blood supply from gastric and splenic arteries; the nerve supply is derived from the autonomic nervous system.

Clinically the movements and conditions of the stomach may be examined by X-rays by passing a gastroscope for direct viewing and by gastric photography.

5.1.6 Small Intestine: Small intestine is a tube of about 18 feet long in life. In the cadaver it is about 20 feet due to the loss of tone of the muscle. It starts from the pyloric orifice of the stomach. The junction between the two being guarded by pyloric sphincter. Position of the sphincter is indicated by the prepyloric vein which crosses infront of the sphincter. Narrowing of the lumen at the junction is due to the pyloric constriction. Small intestine terminates at the ileo-colic junction where it joins the large intestine.

Small intestine mainly lies in the umbilical region within the concavity of large intestine. It is divided into three parts.

Duodenum is the first 10 inches of the small intestine. It forms a C-shaped curve which encircles the head of pancreas. Bile and pancreatic ducts open into the duodenum on a small projection called major duodenal papilla. This opening is about 4 inches from the pylorus. Duodenum is fixed to the posterior wall of abdomen, by peritoneum.

Jejunum forms the upper 2/5 of the remaining small intestine. Terminal 3/5 of the intestine is the ileum. Both jejunum and ileum are suspended from the posterior wall of abdomen by a fold of peritoneum called the mesentery. So these parts are mobile.

Structure: Small intestine has:

1) Outer serous coat formed by peritoneum.

2) Muscular coat with outer longitudinal and inner circular muscle fibers.

3) Submucous coat inside the muscular coat and consisting of loose connective tissue with blood vessels, nerves and lymphatics. In the duodenum it contains Brunner's glands. the mucous secretion of these glands protect the lining of the duodenum from the action of acidic gastric contents. In the ileum submucous coat contains the aggregated lymphatic collections called Peyer's patches. These exercise a protective function and are the sites of inflammation in enteric (Typhoid) fever.

(4) Innermost mucous coat in the small intestine. It has adaptation to increase the surface area of its epithelium. This is very essential as most of the absorption of digested food takes place in the small intestine. Mucous membrane is thrown into circular folds. All over the surface are finger like projections called villi. Glands are present in this coat which produce the necessary juices that are poured into the lumen.

5.1.7. Large Intestine: Large intestine or colon is about 5 feet long. It is continuous with the small intestine at the iliocolic or ilicaecal junction. It receives the residual food from the ileum. Colon begins as a dilated pouch, called caecum, to which vermiform appendix is attached. Appendix may lie below or behind the caecum. It becomes inflammed in appendicitis which generally necessitates the operation of appendicectomy.

Caecum lies in the right iliac region and ascends through the right lumbar region as the ascending colon. Under the liver it turns to the left forming the hepatic flexure. It continues to the left as the transverse colon across the umbilical region. On reaching the spleen it turns down forming the splenic or left colic flexure of the colon. Descending colon in the left iliac region follows a S-shaped course and continues into the lesser pelvis. This part of the colon is called the sigmoid or pelvic colon. In the pelvis it becomes straight and descends as the rectum.

Throughout its course the colon presents small sacculations on its surface and it is wider than the small intestine. Ascending and descending parts of the colon are fixed to the posterior wall of abdomen. Transverse and sigmoid portions of the colon have a mesentery suspending the gut from the dorsal body wall. Large intestine has the same four coats as in other parts of the alimentary canal. Its mucous coat consists of a lot of mucous secreting cells called Goblet cells. (Fig. 9)

Rectum is the lowest 5 inches of the large intestine. It begins from the lower end of sigmoid colon and ends in the anal canal. Lower end of the rectum pierces the pelvic floor to continue as anal canal.

Anal canal is about 1½ inches long. It ends in an aperture called the anus. Rectum and anal canals are empty except during the passage of faeces.

Rectum is structurally similar to that of the colon; but its muscular coat is thicker. The circular musculature of the rectum is

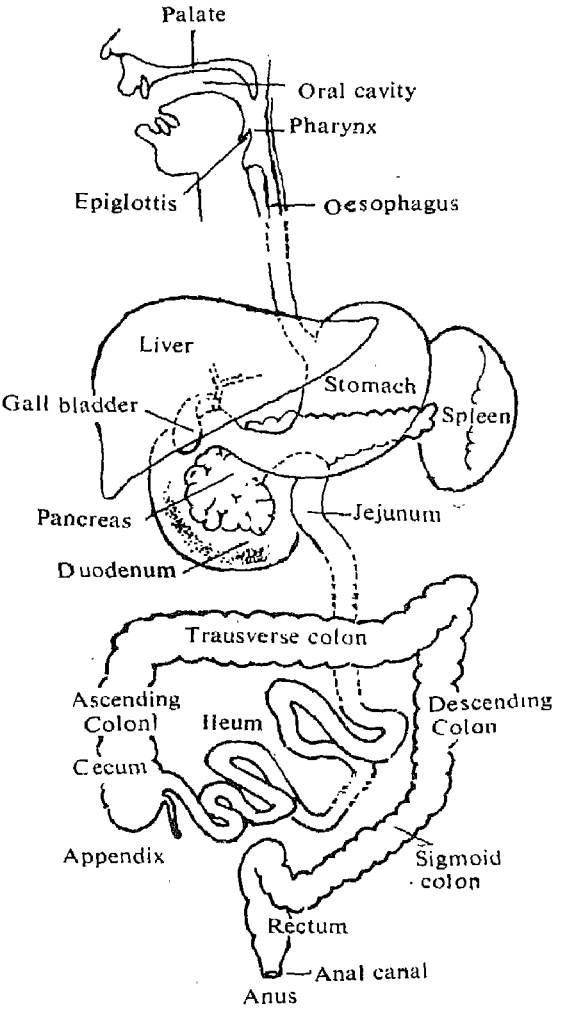

Fig. 9 DIAGRAM OF DIGESTIVE TRACT

thickened and continued around the anal canal as the internal sphincter. Outside the internal sphincter there is an external sphincter which is voluntary. These sphincters keep the anal canal and anus, normally closed. Mucous membrane of the anal canal presents vertical folds in its upper part called anal columns of Morgagni, deep to which there are blood vessels. Enlargement of these blood vessels is responsible for piles. Columnar epithelium of upper part of anal canal changes gradually into skin in the lower part of the anal canal. Upper part of its mucous membrane is supplied by autonomic nerves and so it is pain insensitive for ordinary stimuli. But lower part of the canal is supplied by somatic nerves and so it is pain sensitive. Thus injections can be given to the upper part without eliciting the pain.

5.1.8. Peritoneum: (Fig. 10) Peritoneum is the largest of the serous membranes in the body. It is double layered, one layer lining the walls of abdominal cavity is the parietal layer, the other layer covering the organs in the abdomen is called visceral layer. Both the

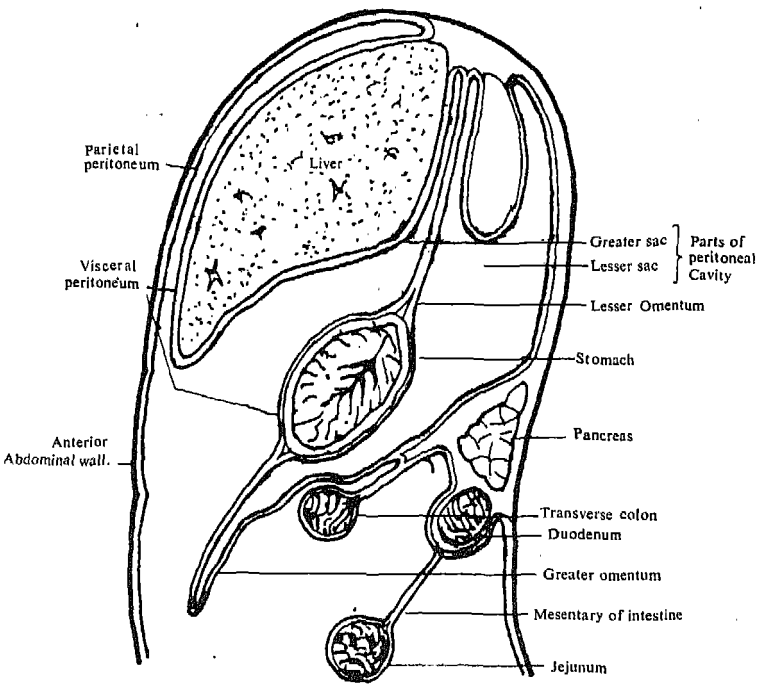

Fig. 10. PERITONEUM

layers are continuous with each other. Potential space between these two layers is called the paritoneal cavity or sac. In the male it is a closed sac. In the female the uterine tubes open into the peritoneal cavity. There are many folds of peritoneum. One such large fold is the greater omentum, containing fat and hanging down from the stomach infront of the small intestine.

Lesser omentum is another fold extending between the liver and the stomach. Peritoneum also forms double layered folds which suspend portions of the gut from the dorsal body wall. Such folds are called mesenteries eg: mesentery of small intestine and transverse mesocolon and sigmoid mesocolon. These mesentaries and the omenta carry the blood vessels and lymph vessels to and from the organs.

Peritoneum forms smooth covering which enables the organs to move upon each other without friction.

5.1.9. Liver Anatomy: The liver is the largest gland in the body, situated in the upper most part of the abdominal cavity on the right side below the diaphragm. It is largely protected by the ribs. It is about 3 lbs in weight.

Liver consists of two main lobes, right and left. The upper surface is convex and lies beneath the diaphragm. A longitudinal fissure separates the right and left lobes on the under surface and a peritoneal fold called falciform ligament separates the two lobes on the upper surface of the liver. The right lobe consists of quadrate and caudate lobes. Liver occupies mainly right hypochondriac and epigastric regions. Inside, the liver substance is made up of polyhedral hepatic lobules. These lobules are composed of cubical liver cells and its duet system, ramifications of the vessels of the liver, all united together by connective tissue. (Fig. 11)

Liver has a double blood supply by means of hepatic artery and portal vein. The hepatic artery supplies 1/5 of the blood to the liver, this supplies the oxygenated blood.

Portal vein supplies 4/5 of the blood to the liver. Portal vein brings the blood rich in nutrients absorbed by the mucosa of the small intestine. Hepatic veins return the blood from the liver to the inferior vena cava.

Bile capillaries collect the bile from the liver cells and unite to from the bile duct. Liver cells are nucleated polyhedral cells containing large number of enzymes. Between the cells are the bile capillaries and blood vessels. Liver is connected with storage and distribution of

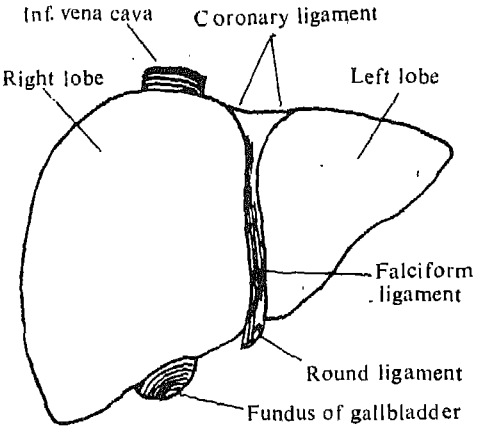

Fig. 11. THE LIVER FROM THE ANTERIOR SURFACE

many substances including glycogen, fat, vitamins and iron. The fat soluble vitamins, A and D, are stored in the liver. That is why liver oils are good sources of these substances. (Fig. 12)

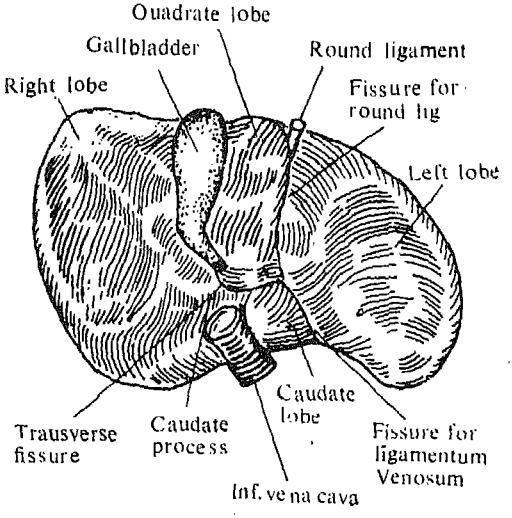

Fig. 12. POSTERO-INFERIOR SURFACE OF THE LIVER

5.1.10. Gall-Bladder: It is a pear-shaped musculo-membranous bag, lying in a fosse on the under surface of the liver. It is about 3 to 4 inches in length and holds about 50 ml of bile. Its blind end called the fundus may project from the inferior border of the liver. Gall bladder stores the bile and concentrates it. It is lined by columnar epithelium.

Gall bladder leads to a duct called the cystic duct. This cystic duct joins with the hepatic duct which emerges from the liver to form the bile duct. Bile duct passes down posterior to the beginning of duodenum and head of the pancreas. It joins with the main pancreatic duct to form the hepatopancreatic duct. This enlarges to form an ampulla which opens on the summit of a major duodenal papilla situated 3 to 4 inches from the pylorus. Gall bladder and bile duct are supplied by branches of hepatic artery. Infection of gall bladder is called cholecystitis. Gall stones may be formed in the gall bladder. When the stones obstruct the hepatic ducts, bile cannot escape from the liver leading to obstructive jaundice. Stones in the gall bladder and cystic duct do not give rise to jaundice.

5.1.11. Pancreas (Fig. 13): Pancreas is a soft, lobulated, greyish-pink gland, 5 to 6 inches long. It is situated across the posterior abdominal wall. It extends from the duodenum to the spleen. It consists of an expanded right extremity called the head of the pancreas which lies in the curve of the duodenum. Succeeding the head is a slight constricted neck which leads to the body of the pancreas. Body lies behind the stomach and in front of the first lumbar vertebra. Body leads to the terminal left extremity of the pancreas called

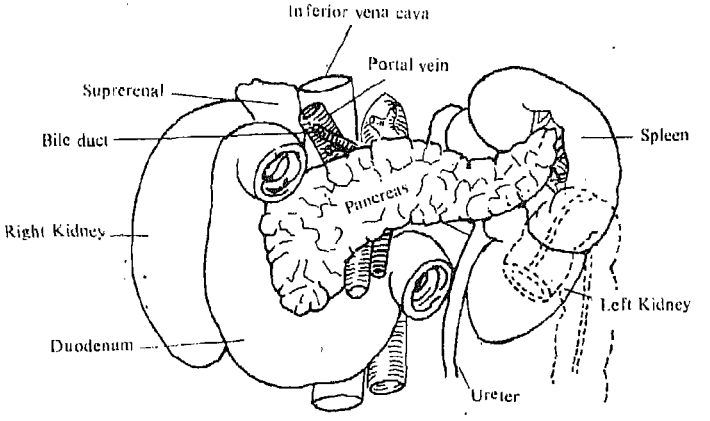

FIG.13. ABDOMINAL VISCERA

the tail. It is narrow and is in contact with the spleen.

Pancreas is supplied by the splenic artery. The substance of the pancreas consists of small subdivisions called lobules. These are made up of clusters of secretary units called alveoli. These alveoli lead to duct system. So these portions constitute the exocrine part of the pancreas. Pancreatic juice secreted by this portion of the pancreas passes through the pancreatic duct which joins with the bile duct to form the hepatopancreatic duct and amuplla which open into the duodenum 3 to 4 inches from the pylorus. Between the clusters of pancreatic alveoli there are irregular areas called Islets of Langerhans. The cells of the Islets secrete the insulin which directly pours into the adjacent enlarged blood capillaries. So this portion of the pancreas is the endocrine portion. This is mainly concerned with the secretion of insulin. Degeneration or dysfunction of Islet tissue leads to diabetes.

5.2. Spleen

Spleen lies in the left hypochondriac region of the abdomen, between the fundus of the stomach and the diaphragm. It is a blood forming organ, it consists of lymphocyts and red blood corpuscles. In the adult it mainly functions as storage organ of blood cells. It is not very essential for the life.

5.3. Heart

The heart is a hollow, muscular organ of a some what conical form. It lies in the thorax between the two lungs and pleurae, posterior to the body of the sternum and adjoining parts of the cartilages of the ribs. One third of the heart lies on the right of the median plane; 2/3 of the heart lies on the left of the median plane. (Fig. 14)

Size: In the adult, heart is about 280 grammes.

Base of the heart is directed backwards. Apex is directed downwards and forwards. In its interior it consists of 4 chambers. Two are receiving chambers called the artria, other two are pumping chambers called ventricles. These chambers are separated by septa in the interior, the position of which is indicated on the surface of the heart grooves. These grooves contain the blood vessels supplying or draining the heart. Right portion of the heart that is right atrium and right ventricle contain the impure (Deoxygenated) blood. Left portion, that is, left atrium and ventricle contain the oxygenated blood. The right atrium receives the blood mainlyfrom the head, neck and upper limbs through a large vein called the superior ven cana. It also

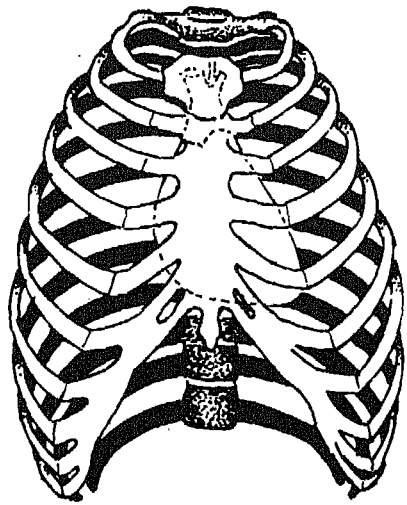

Fig. 14. THE POSITION OF THE HEART IN RELATION TO THE STERNUN, RIBS AND COSTAL CARTILAGES

receives deoxygenated blood from the lower limbs, major part of the trunk and abdominal organs, through the inferior vena cava. Venous blood from the walls of the heart is brought to the right atrium by a vein called coronary sinus. The blood from the right atrium is pumped into the right ventricle through the right atrio ventricular opening. This communication between these two chambers is guarded by a valve which has three segments. So it is called tricuspid orifice. These segments or cusps of the valve prevent the back flow of blood from the right ventricle to the right atrium. (Fig. 15)

From the right ventricle a large artery called pulmonary trunk arises but the junction between the two is called pulmonary orifice which is again guarded by pulmonary valve. This prevents the back-flow of blood from the pulmonary trunk to the right ventricle. Pulmonary trunk divides into two pulmonary arteries, one for each lung. Within the lung pulmonary artery divides into its terminal branches where exchange of gases takes place between the blood in the capillaries and air in the pulmonary alevoli. Oxygenated blood from the lungs is returned to the left atrium by pulmonary veins. There are two such veins from each lung. Thus the 4 pulmonary veins open into the left atrium. Circulation of blood through the lungs

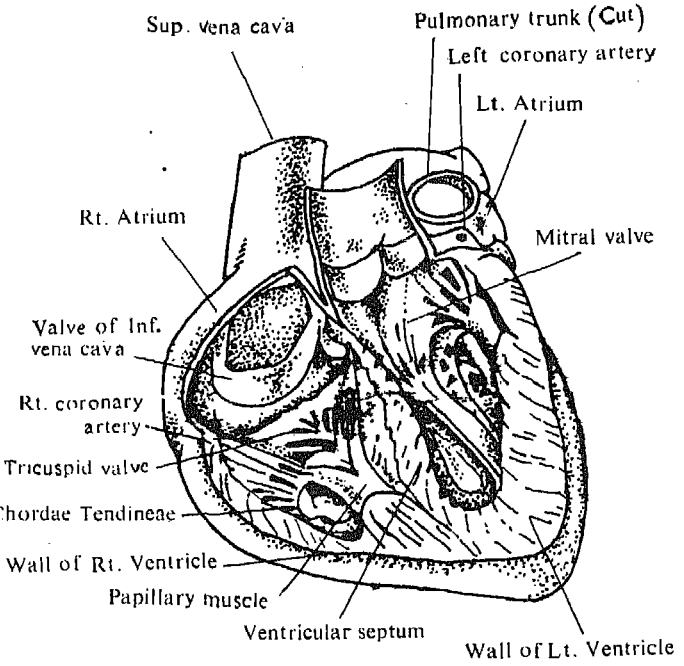

Fig. 15. THE INTERIOR OF THE HEART

constitutes the pulmonary circulation. (Fig. 16)

Blood from the left atrium enter the left ventricle through the left atrioventricular opening. This opening is guarded only by two segments or cusps and is therefore called bicuspid orifice or mitral orifice. These cusps prevent the back flow of blood into left atrium. Left ventircle leads to the ascending aorta, the junction between the two is the aortic orifice guarded by aortic valve. Ascending aorta is the large artery which carries the blood from the heart to be distributed to various parts of the body, from where large veins bring the deoxygenated blood back to the right atrium. This constitutes the systemic circulation. (Fig. 17)

Surface of the heart is covered by a serous membrane called epicardium. Musculature of the heart is called the myocardium. It is involuntary in nature. Some of these muscle fibers are specialized to form what is called the conducting system of the heart. Conducting system includes (1) sinuatrial node which creates the cardiac impulses, (2) atrioventricular node which transmits these impulses to

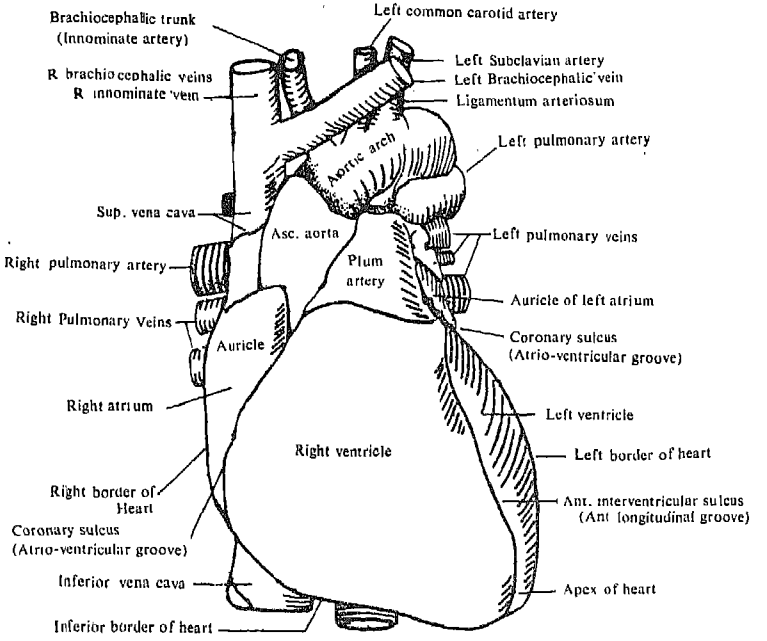

Fig.16. HEART AND GREAT VESSELS HARDENED IN SITU AND REMOVED EN MASSE STERNOCOSTAL ASPECT

(3) atrioventricular bundle. This bundle distributes the impulses to ventricular musculature.

Inner most lining of the heart is called endocardium which is continuous with the lining of the large blood vessels communicating with the heart.

Wall of the heart is also supplied by blood vessels for its nutrition. Coronary arteries, branches of ascending aorta supply the heart and coronary sinus brings the venous blood from the heart into the right atrium.

Heart is enclosed in a conical fibrous bag called fibrous pericardium. Within this bag there is serous pericardium consisting of two layers—(1) a visceral layer, closely covering the surface of the heart and forming the epicardium, (2) a parietal layer lining the inner surface of fibrous pericardium. Visceral and parietal layers are continuous with each other. The potential space between them is the pericardial cavity with serous fluid. This fluid has a lubricating action and allows the heart to move freely.

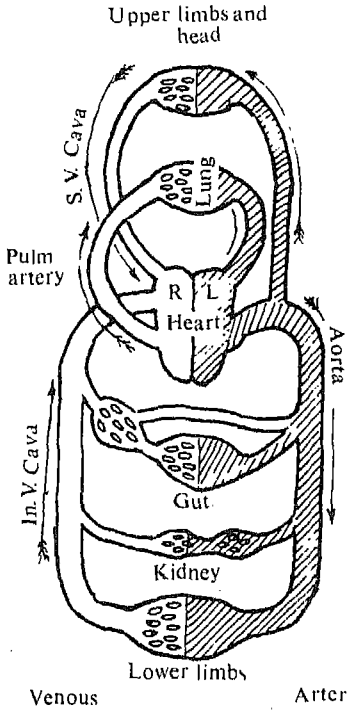

Fig. 17. DIAGRAM OF THE CIRCULATORY SYSTEM

Two sounds may be heard during the action of the heart due to the passive closing of the valves. First sound is due to the closing of the atrioventricular valves, and the contraction of the ventricles—it is like "lubb". Second sound is due to the closing of aortic and pulmonary valves during the dilatation of ventricles; it is short and sharp like "dup". Extra noises are due to deformities in the valves or other chambers, these are usually called "murmurs".

Phytmicity of the heart is controlled by automatic nerves. Tenth cranial nerve supplying parasympathetic fibers to the heart decrease the heart rate, sympathetic fibers increase the heartrate.

Arteries carry the blood away from the heart and veins bring the blood to the heart. Large arteries arising from the heart are (1) pulmonary trunk which carries the blood to the lungs from right ventircle and (2) ascending aorta which carries the blood to the various parts of the body from the left ventricle.

Ascending aorta gives right and left coronary arteries to supply

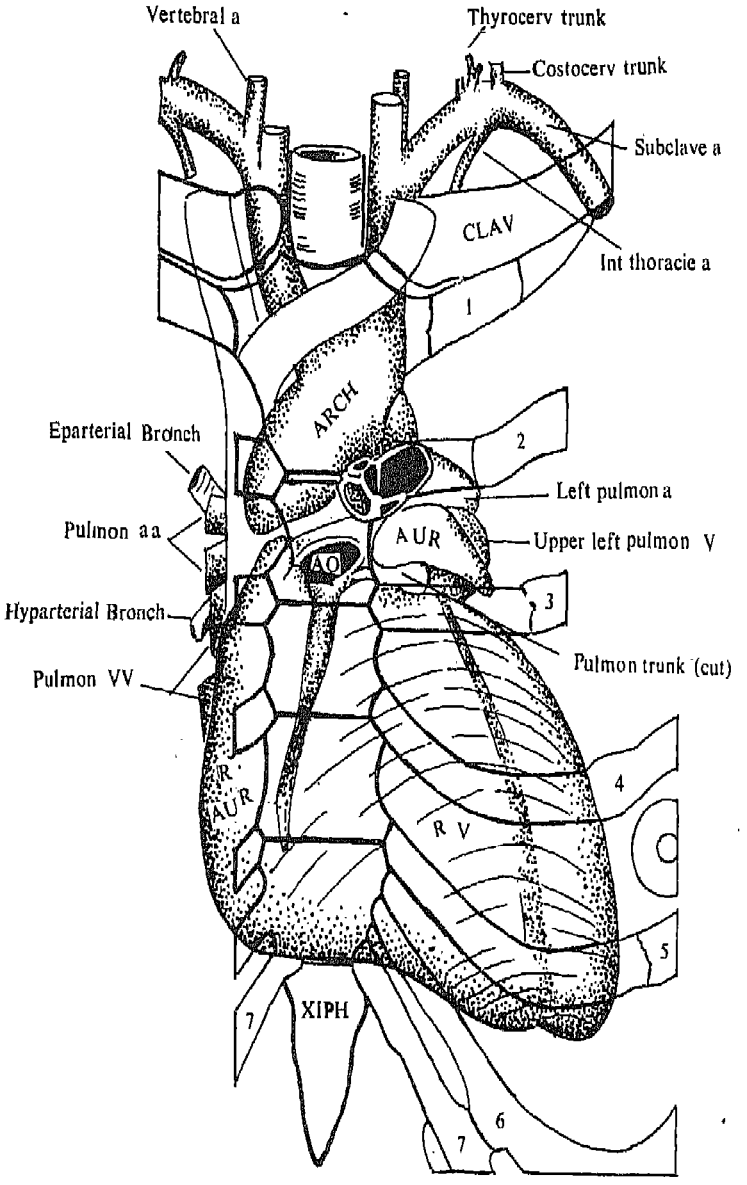

Fig. 18 HEART GREAT VESSELS AND STERNOCOSTAL RELATIONSHIP

arterial blood to the heart. Then it continues as the arch of aorta. Arch of aorta gives three main branches called innominate artery, left common carotid and left subclavian arteries. Innominate artery divides into right subclavian and right common carotid arteries. Subclavian arteries on both sides are continued mainly to supply the upper limbs but also supply some of the structures in the neck like oesophagus, larynx trachea, thyroid gland etc. One of its large branch called vertebral artery also supplies the brain.

Common carotid arteries on both sides divide into internal and external carotid arteries. As the name indicates internal carotid artery mainly supplies the brain inside the brain case or cranium. External carotid mainly supply the face and the neck region.

After giving the above three branches, the arch of aorta continues as the descending aorta along the dorsal wall of thorax and abdomen. It supplies the lungs for nutrition and walls of therax, wall and viscera of abdomen through its various branches. At the level of 4th lumbar vertebra it divides into two branches called common iliac arteries. Each of these divide into internal and external iliac arteries. The internal iliac arteries supply walls and organs of pelvis. The external iliac artery continues to the lower limb for its blood supply.

Arteries divide into smaller branches and end in terminal hair like ramifications called capillaries. Through the walls of these capillaries exchange of substances take place between the tissue fluid and blood. Capillaries lead to smallest veins called venules which unite to form larger veins. Ultimately blood is returned from various parts of the body into the heart by superior and inferior vena cavae which open into right artium.

All these blood vessels are lined internally by endothelium continuous with the endocardium lining the heart. Aorta has lot of elastic fibers in its wall. In the smaller arteries muscle fibers predominate. In the capillaries there is no muscular wall but only endothelial wall persists.

5.4 Lymphatic System

Lymphatic system consists of lymph capillaries which drain the tissue fluid. Lymph capillaries unite to form lymph vessels. These lymph vessels drain the lymph to the great veins, at the root of the neck through lymph nodes. Largest lymph vessel in the body is called thoracic duct which opens into a large vein called left brachiocephalic vein at the root of the neck.

Tissue fluid is the fluid that bathes the cells of the tissues of the body. It resembles the blood plasma in chemical composition. From this fluid the cells get their nutritive material, to it they give their waste products of metabolism; and through it they respire. Between the tissue fluid and the plasma of the circulating blood a constant interchange of fluid and dissolved substances take place through the semipermeable walls of the capillaries. So the tissue fluid is refreshed. But some of the tissue fluid is carried back to the blood circulation through another path that is the lymphatic system. This part of the tissue fluid is called the "lymph". Lymph is a clear, colourless fluid; lympnocytes are added to it as it passes through the lymph glands.

Lymph nodes (glands) are small, pink, flattened structures in life. They act as filters for lymph and factories for lymphocytes. Lymph nodes act on the foreign substances that may be present in the lymph and thus play a role in immunity reaction. If they fail to suppress the foreign substances, they themselves may be infected and enlarged.

There is a group of lymph nodes in the axilla or armpit between the upper part of the side of the trunk and the arm. These lymph nodes receive most of the lymph vessels from the breast and upper limb. In cases of cancer of the breast these lymph nodes are enlarged.

Most important lymph nodes in the neck are situated below the lower jaw, and vertical chain of lymph nodes on either side of the median plane, infront of the neck. These lymph nodes receive the lymph vessels from the various organs and different parts of the head and neck. Enlargement of these lymph nodes indicate the infections of particular organs or parts.

The region between the front of the thigh and abdomen is called inguinal region. Lymph nodes in this region are called inguinal lymph nodes which receive the lymph from the lower limbs, most of the lymph vessels from the external genital organs and neighbouring regions. Within the pelvis, abdomen and thorax there are definite sets of lymph nodes draining the particular organs.

In the recent years lymphatic system has gained the maximum importance in the spread of diseases like cancer, tuberculosis etc.

5.5. Respiratory System

Respiratory system includes the parts concerned with air passage and the lungs where gaseous exchange takes place.

5.5.1. Nasal passage and pharynx: Air entering the nose through

the anterior nasal aperture passes through the nasal cavity and enters the nasopharynx. Hairs present near the apertures act as seive to remove the dust and other foreign particles in the air. Uppermost part of nasal cavity is lined by olfactory epithelium supplied by olfactory nerves. This part perceives the odour or smell of the inspired air. In to the lateral wall of nasal cavity paranasal air sinuses open. These are the cavities within the bones around the nasal cavity and they are lined by mucous membrane.

Air passes through the pharynx. Thus the lower part of the pharynx is the comman passage for both food and air. From the

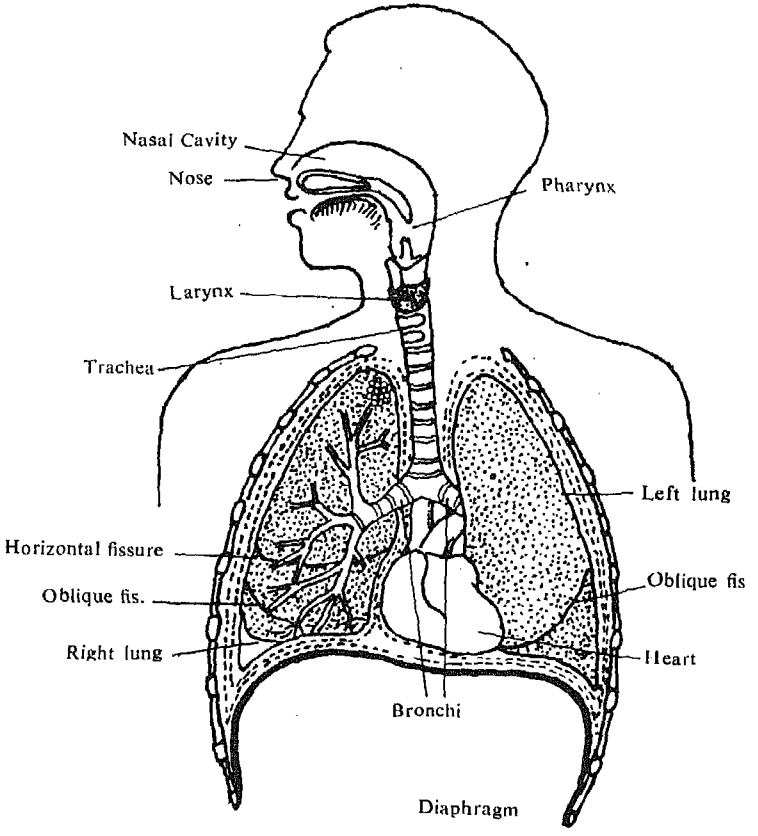

FIG.1 . DIAGRAM OF RESPIRATORY SYSTEM

lower part of the pharynx air enters the larynx through a slit like aperture called inlet of the larynx. This inlet is usually closed by epiglottis during the passage of food and thus prevents the food from entering into the larynx.

5.5.2. Larynx: It is an organ of production of voice and air passage. It is made up of cartilages which are connected by ligaments and are moved on one another by muscles. Its largest cartilage called thyroid cartilage forms a median projection in the neck called laryngeal prominance or Adam's apple. In the interior of larynx there are two important folds of mucous membrane called vocal folds one on each side. The interval between these is called rima a glottidis. Passage of air through this interval and vibration of vocal folds produces the voice.

Larynx inferiorly becomes continuous with the trachea or windpipe. The trachea passes through the lower part of neck and upper part of thorax. At the level of sternal angle trachea divides into two principal bronchi. Walls of the trachea and bronchi are supported by C-shaped cartilagenous rings. In the posterior part of trachea the cartilaginous rings are deficient and it is filled by fibrous tissue and muscle fibre. Interior of the trachea and bronchi are lined by ciliated columnar epithelium with lot of goblet cells secreting the mucous. Foreign particles may stick to this secretion and may be expelled due to cough reflex.

Each principal bronchus enters into the respective lung. Within the lungs they divide dichotomously. Smallest subdivisions are provided with very thin walled sac-like structures called pulmonary alveoli, like the bunches of grapes.

5.5.3. Lungs (Fig. 20): Lungs are the respiratory organs. They

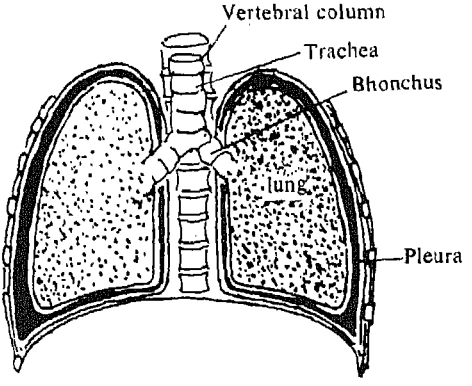

Fig. 20. DIAGRAM TO SHOW THE LUNG AND PLEURAE

are situated one in each half of the thoracic cavity. They are conical in shape and each is enclosed in a serous sac called the pleura.

Pleuras are serous sacs covering the lungs and lining the thoracic wall. Thus pleura consists of two layers; 1) Parietal pleura lining the chest wall and 2) Visceral pleura covering the lungs closely. These two layers are continuous with each other around and below the root of the lung. Potential space between the two layers of the pleura is the pleural cavity, lubricated by a thin film of serous fluid. The space between the two pleural sacs is called mediastinum which contains the heart and great vessels.

Bases of the lungs are related to the diaphragm. Apex of each lung extends into the root of the neck. On the medial surface of the lung there is a depression called hilus where structures enter or leave

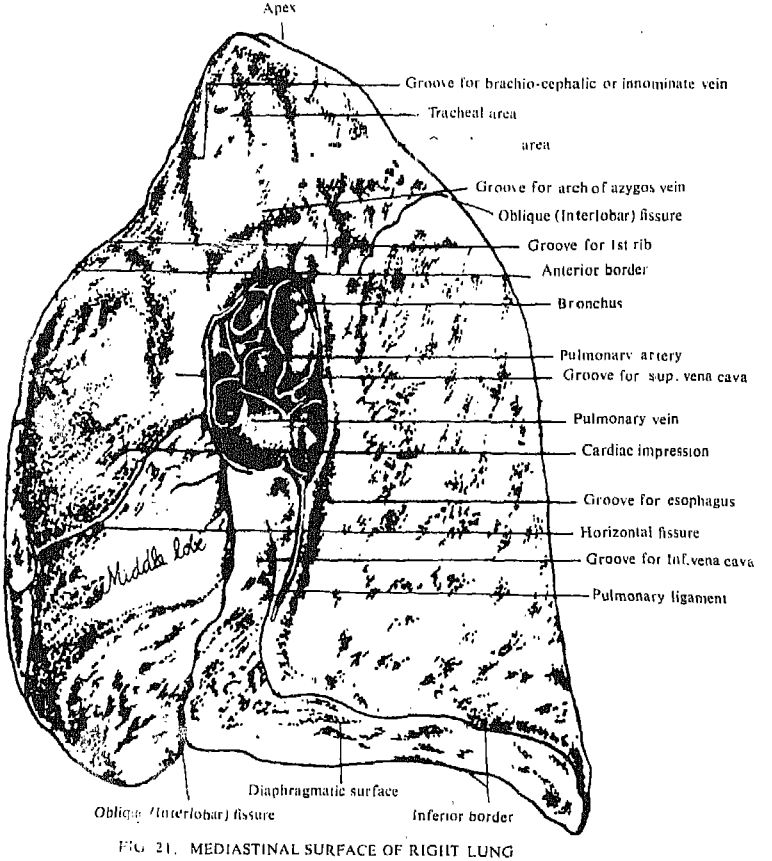

FIG. 21. MEDIASTINAL SURFACE OF RIGHT LUNG

the lung. These structures together constitute the root of the lung.

Right lung is broader and shorter where as left lung is longer and narrower. Right lung is divided into three lobes by two fissures called oblique and horizontal fissures. The lobes are called upper, middle and lower. Left lung is divided by the oblique fissure into upper and lower lobes. (Fig. 21 & 22).

Inside the lungs consist of subdivisions of the bronchial tree, blood vessels, nerves and lymph vessels. On the surface of the alveoli, there is a rich network of capillary plexus. Alveoli are lined by single layer of flattened cells. Exchange of gases takes place between the air in the alveoli and blood in the capillary network.

Pulmonary vessels supply the lungs for oxygenation. Nutrition to the lungs is provided by bronchial vessels.

5.6 Kidney and Associated Organs

Kidneys are bean shaped organs situated in the lumbar region of abdomen on each side of the vertebral column. They are concerned

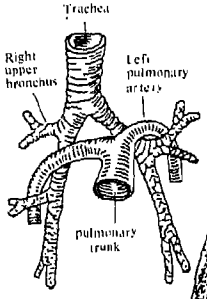

Fig. 22 b
LUNG ROOTS

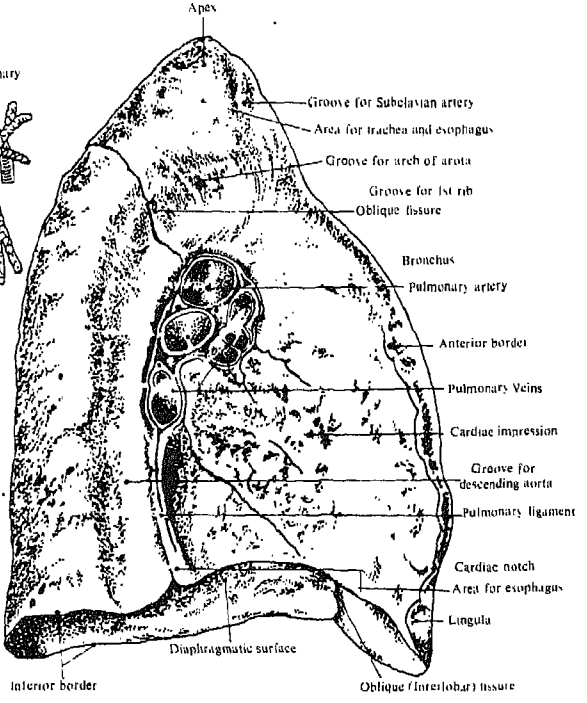

Fig. 22 a MEDIASTINAL SURFACE OF LEFT LUNG

with the production of urine. On the medial border of the kidney there is a depression called hilus where blood vessels enter or leave the kidney and the ureter emerges. Arterial supply is derived from renal artery. Renal vein draining the kidney empties into the inferior vena cava. Near the upper pole of each kidney adrenal gland is closely related. (Fig. 23)

Interior of the kidney consists of two main parts—an outer cortex and an inner medulla. Functional unit of the kidney is called a nephron. Each nephron consists of a renal corpuscle and renal tubules. In the renal corpuscle there is a capillary bed called glomerulus within a double layered cup called Bowman's Capsule. Most of the fluid component of the blood of the glomerulus is filtered into the cavity of the Bowman's Capsule which in turn is continuous with the renal tubule. As the fluid is passes through the tubules reabsorption of water and certain salts takes place. Remaining small portion of the fluid component enters into the larger ducts called collecting ducts as the urine. From the collecting ducts urine passes to the ureter. Renal corpuscles and tubules are present in the cortex but a small segment of renal tubules is present in the medulla.

Ureters are cylindrical thick walled tubes which carry the urine from the kidneys to the bladder. They are about 10 inches in length. Upper end of each ureter is expanded to form a funnel shaped pelvis which divides into major and minor calyces. Into the minor calyces the collecting ducts open. Ureters pass down in the abdomen and enter the pelvis. In the pelvis they open into the urinary bladder.

Urinary bladder is the reservoir for urine. In the empty condition it is tetrahedral in shape. It lies behind the pubic symphysis. Its average capacity is about 220 c.c. but it can be distended upto 500 c.c. under will. But after this reflex contractions of the bladder leads to its emptying.

From the bladder urine pases out through a canal called urethra. In male urethra is longer about 7 to 8 inches in length. Its commencement is surrounded by the prostate gland and so this part of urethra is called prostatic urethra. Into this part semen is discharged through the ejaculatory ducts. Terminal larger portion of the urethra is present in the spongy tissue of the penis and is called spongy urethra. It opens near the tip of the penis as external urethral orifice.

In female the urethra is short. It is about 2 inches in length and is situated in the anterior wall of vagina.

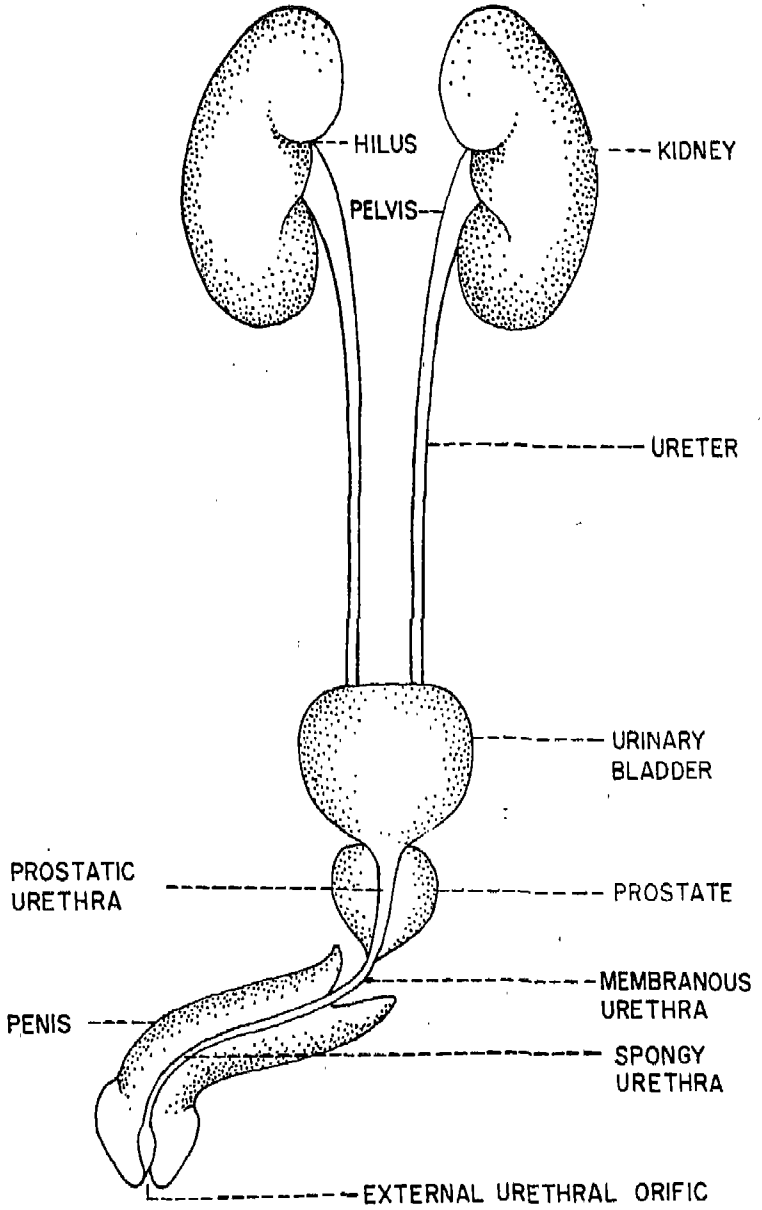

Fig 23 URINARY SYSTEM IN MALE

Commencement of the urethra from the bladder is the internal urethral opening. The outer opening of the urethra is called external urethral orifice.

5.7 Reproductive Organs

The reproductive organs include the gonads which are concerned with the production of germ cells or gametes and associated organs concerned with passage and maintenance of these gametes. In females the organ which shelters the prenatal development of its offspring and the copulatory organs in both sexes are also included in this system.

5.7.1 Male reproductive organs: Consist of the following organs: (Fig. 24).

Testes: These are the male gonads concerned with the production of gametes called sperms. They are situated one in each half of the scrotum which is a pouch of skin between the two thighs. Within the testis there are numerous conical compartments which contain highly coiled tubules called seminiferous tubules. Sperms are pro-

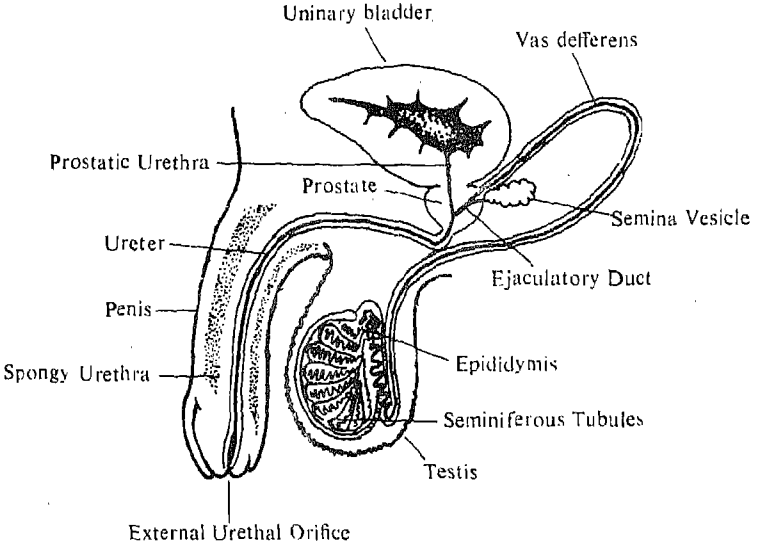

FIG 24. DIAGRAM OF REPRODUCTIVE SYSTEM IN MALE

duced in the seminiferous tubules. Between these tubules are interstitial cells forming the endocrine part. From the seminiferous tubules the sperms pass to the epididymis which is a flattened body on the posterior aspect of the testis. *Epididymis* consists of an upper part called head, middle portion called the body and a lower portion called the tail. Tail of the epididymis continues as the *vas deferens* which is a thick walled muscular tube. Vas deferens with the blood vessels and nerves to the testis constitutes the spermatic cord which is covered by three thin coverings. Spermatic cord extends from the upper pole of the testis, passes through an inter muscular canal called inguinal canal in the lower part of anterior abdominal wall and enters into the abdomen. Vas deference leaves the other structures of the spermatic cord in the abdomen and passes into the pelvis, on to the posterior surface of the urinary bladder.

On the posterior surface of the urinary bladder there is a conical body called *seminal vesicle.* Seminal vesicle consists of a single duct highly coiled on itself and these various convolutions are united by connective tissue. It secrets a fluid containing fructose which nourishes the sperms and adds to the volume of semen. From the lower end of the seminal vesicle a duct arises which joins with the respective vas deferens to form the *ejaculatory duct.*

Beginning of *urethra* is surrounded by a gland called *prostate.* It is partly glandular and partly fibremuscular organ. Glandular portion of the prostate produces the prostatic secretion rich in alkaline phosphatase. Its secretion is poured into the prostatic portion of urethra. Secretions of prostate and seminal vesicle form the bulk of the semen.

Prostate is traversed by ejaculatory ducts, which open into the prostatic portion of urethra. Sperms are stored in the lumen of the epididymis. From the epidedymis they pass through the vas deferens and ejaculatory duct into the prostatic urethra. From here the semen passes through the spongy urethra of the *penis* and discharged through the external urithral orifice. Penis acts as the male copulatory organ.

5.7.2. Female Reproductive Organs (Fig. 25): Female reproductive system consists of ovaries, uterine tubes, uterus and vagina.

Ovaries: Ovaries are two in number situated one on each side wall of the pelvis. They are the female gonads producing the gametes called ova. In each menstrual cycle only one ovum matures from any one of the ovaries. Within the ovary the ova are situated in structures

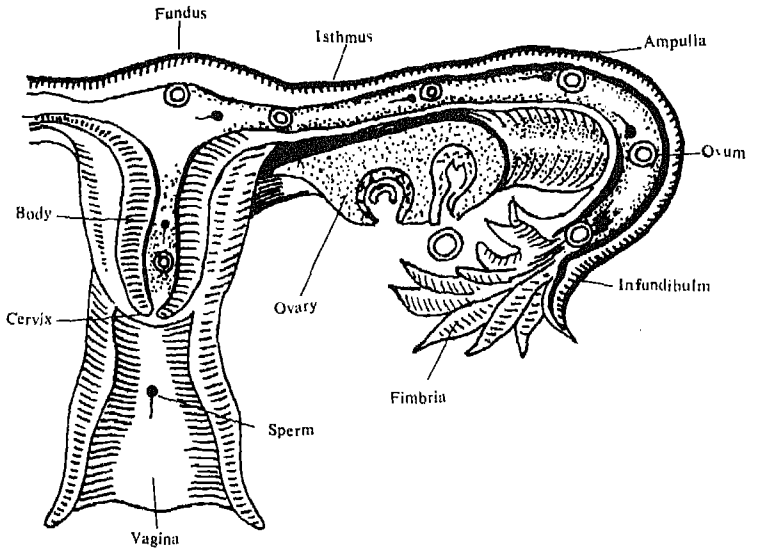

Fig. 25. DIAGRAM OF REPRODUCTIVE SYSTEM IN FEMALE

called ovarian follicles. When a ovum matures within the ovarian folicle the follicle enlarges to form Graafian follicle and ruptures. The ovum thus liberated from ovary comes into the peritoneal cavity. After the discharge of ovum the empty Graafian follicle develops into an endocrine organ called corpus luteum. Life span of corpus luteum depends only on fertilization of ovum.

Uterine tubes are cylindrical muscular tubes one on each side of uterus. Each tube is 4 inches in length. Its medial end opens into uterus and lateral end opens into the peritoneal cavity.

Ovum liberated into the peritoneal cavity from the ovary enters into the uterine tube. Due to the contraction of the muscular wall and beating of the cilia in the lining epithelium of the uterine tube, the ovum passes along the uterine tube towards the cavity of the uterus.

Uterus: (Fig. 26) It is a thick walled muscular organ situated in the pelvis infront of the rectum and behind the irinary bladder. It is about 3 inches in length, 2 inches in breadth and 1 inch in thickness. Its weight is about 1½ oz. It has an upper portion called fundus, middle portion called body and a lower portion called cervix. Mucous membrane of the uterus is called endometrium, superficial portions of the endometrium are shed off in each menstrual flow and

repaired subsequently under the influence of female sex hormones.

Vagina is the female copulatory organ. It is a muscular organ lined by stratified squamous epithelium. Cervix of the uterus projects into the vagina and its cavity opens into the cavity of vagina. Lower end of the vagina opens into the vestibule bounded between the labia minora.

During copulation sperms deposited in the vagina pass up through the uterus and then enter the uterine tube. As the ovum traverses the uterine tube sperms usually fertilize the ovum in the lateral part of the uterine tube. Fertilized ovum passes into the uterine cavity and implants to the fundus of the uterus where it undergoes prenatal development.

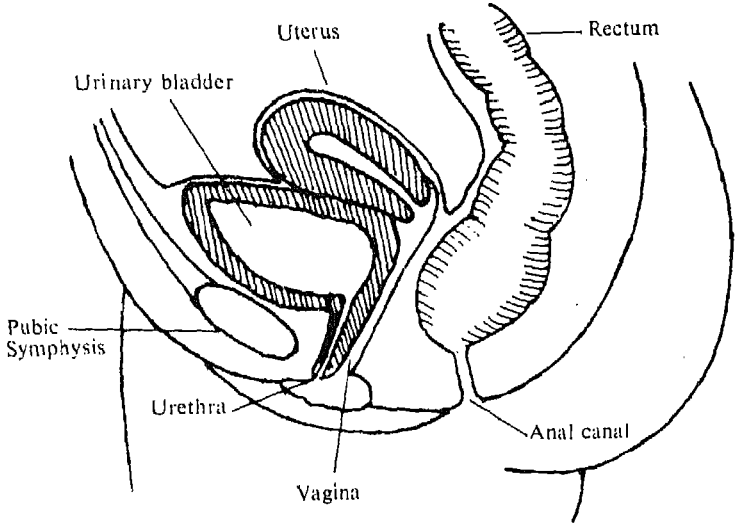

Fig. 26. DIAGRAM TO SHOW THE POSITIONS OF RECTUM UTERUS AND URINARY BLADDER

6. Surface Anatomy of Important Internal Organs

6.1 Heart

Heart lies in the thorax, between the lungs and behind the sternum, and directed more to the left than the right side.

A line drawn from the third right costal cartilage half an inch from the sternum, upwards to the second left costal cartilage three quarters of an inch from the sternum, marks the position of the superior border of the heart.

A point marked on the left side between the left fifth and sixth ribs or in the fifth left intercostal space three and a half inches from the midline gives the position of the apex of the heart, which is the pointed extremity of left ventricle.

Right border of the heart corresponds to a line drawn from the upper border of right third costal cartilage 1.2 cm from the margin of the sternum, downwards to the sixth costal cartilage. This line is gently convex to the right and is at its maximum distance from the median plane—3.7 cm.—in the fourth intercostal space.

Lower border of the heart can be represented by a line joining the lower end of the right border to the apex of the heart. It passes through the xiphisternal joint.

Left border of the heart is represented by a line drawn from the apex upwards and medially to a point on the lower border of the left second costal cartilage, 1.2 cm. from the sternal margin. (Fig. 27)

Pulmonary orifice lies partly behind the upper border of the left third intercostal space down wards and to the right.

Right atrioventricular orifice can be represented by a line, 4 cm long, commencing in the median plane opposite the 4th costal cartilage, and passing downwards and slightly to the right; centre of this line should be opposite the middle of the 4th intercostal space.

Left atrioventricular orifice lies behind the left half of the sternum opposite the fourth costal cartilage and can be represented by a line, 3 cm long, downwards and to the right.

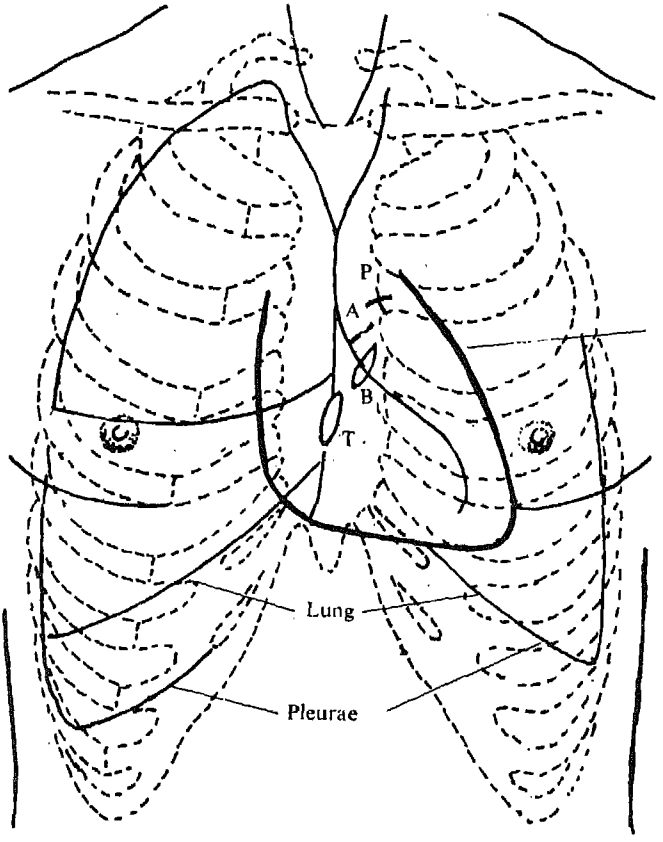

Fig. 27. Ventral aspect of the thorax. Showing Surface progections Skeletal, pulmonary pleural and Cardiac. A. Orifice of aorta B. Left atrioventricular (mitral) orifice. P. Orifice of pulmonary trunk T. Right atrioventricular (tricuspid) orifice

6.2 Radial Artery

Take the following points for the surface marking of radial artery.

First point: 1 cm. below the level of the joint between the upper arm and forearm called elbow.

Second point: is above the lateral part of the front of the wrist joint in front of the lower end of the radius. Join these two lines—that indicates radial artery.

6.3 Median Cubital Vein

Take a point on the lateral border of forearm 2 cm below the bend of the elbow; another point 2 cm above the elbow on the medial border of arm. Join these two points. This vein connects cephalic to the basilic vein.

6.4. Femoral Artery

Can be represented by upper 2/3 of a line drawn from a point midway between the anterior superior iliac spine and symphysis pubis to the adductor tubercle which is a small bony elevation on the upper medial part of lower end of femur.

6.5. Femoral Vein

Lies medial to upper part of femoral artery and lateral to lower part of the artery. In the middle it crosses behind the artery.

6.6 Lungs

Anterior border of right lung: Take the following points:

1) A point about 2.5 cm above the junction of the medial and middle third of the clavicle.

2) Another point opposite the sternoclavicular joint.

3) Third point in the median plane opposite the sternal angle.

4) A point on the xiphisternal joint.

Line joining these four points indicates the anterior margin of the lung.

Anterior margin of left lung: Take the following points:

1) A point 2.5 cm above the junction of medial and middle thirds of the clavicle.

2) Point opposite the left sternoclavicular joint.

3) Another point in the median plane opposite the sternal angle.

4) Fourth point in the median plane opposite the 4th costal cartilage. (Fig. 28-29)

Join these points by a line. From the lower end of this line the anterior border of left lung deviates to the left side for a distance of 3.5 cm and then curves downwards to reach the sixth costal cartilage at a point 4 cm from the median plane.

Lower border can be represented by a line drawn from the lower end of the anterior border downwards, backwards and upwards

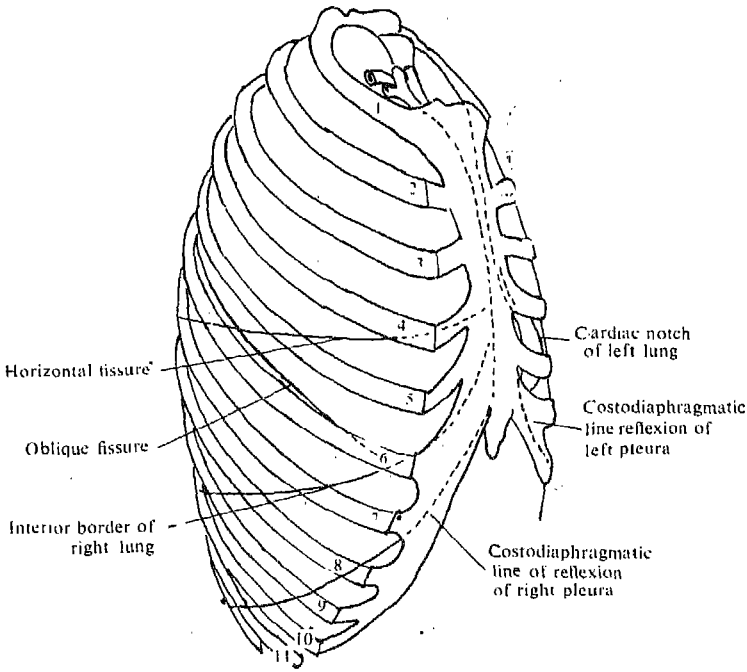

Fig. 28 The relations of the pleurae and lungs to the chest wall
Right lateral aspect. Purple lungs, covered with the sacs with no underlying lung

across the 8th rib in the mid axillary line and ends 2 cm lateral to the tenth thoracic spine.

Posterior border of the lung can be represented by a vertical line drawn from a point 2.5 cm lateral to the seventh cervical spine to a point 2 cm lateral to the tenth thoracic spine.

6.7. Liver

Upper border: Take a point on the right 4th intercostal space in the mid clavicular line; another point in the left fifth intercostal space in the mid clavicular line 7.6 cm from the median plane. Take a third point opposite the xiphisternal joint. Join these points by a curved line, which is convex upwards in its right half and concave upwards in its left half. (Fig. 30)

Right border: Take a point 1.2 cm below the tip of the tenth

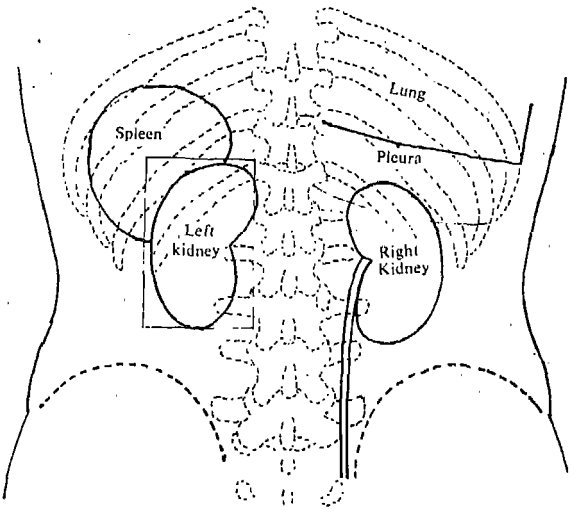

Fig 29 THE LOWER PORTIONS OF THE LUNG AND PLEURA. VIEWED FROM BEHIND LOWER PORTIONS OF THE LUNG AND PLEURA ARE SHOWN ON THE RIGHT SIDE

costal cartilage and join this point with the right extremity of the upper border by a curved line convex to the right.

Inferior border: Take a point 2.5 cm above the level of first lumbar vertebra on the median plane and another point opposite the tip of the right ninth coastal cartilage. Connect these points by a line and continue this line to the left end of the upper border and lower end of the right border.

Transpyloric plane: It is horizontal plane drawn at the midpoint between upper border of the sternum and pubic symphysis. It corresponds to the lower border of first lumbar vertebra.

6.8. Stomach

Cardiac orifice: It is the opening of oesophagus to the stomach. It lies behind the 7th costal cartilage 2.5 cm to the left of the median plane. Pylorus lies on the transpyloric plane 1.2 cm to the right of the median plane. Lesser curvature of the right border of the stomach can be represented by a J shaped line by joining the right margin of cardiac orifice to the upper margin of pyloric orifice. Fundus of the stomach corresponds to a line covex upwards, and drawn from the left margin of the cardiac orifice to a point in the left fifth intercostal space in the mid clavicular line. Greater curvature or left border of the stomach can be represented by a curved line convex to the left and

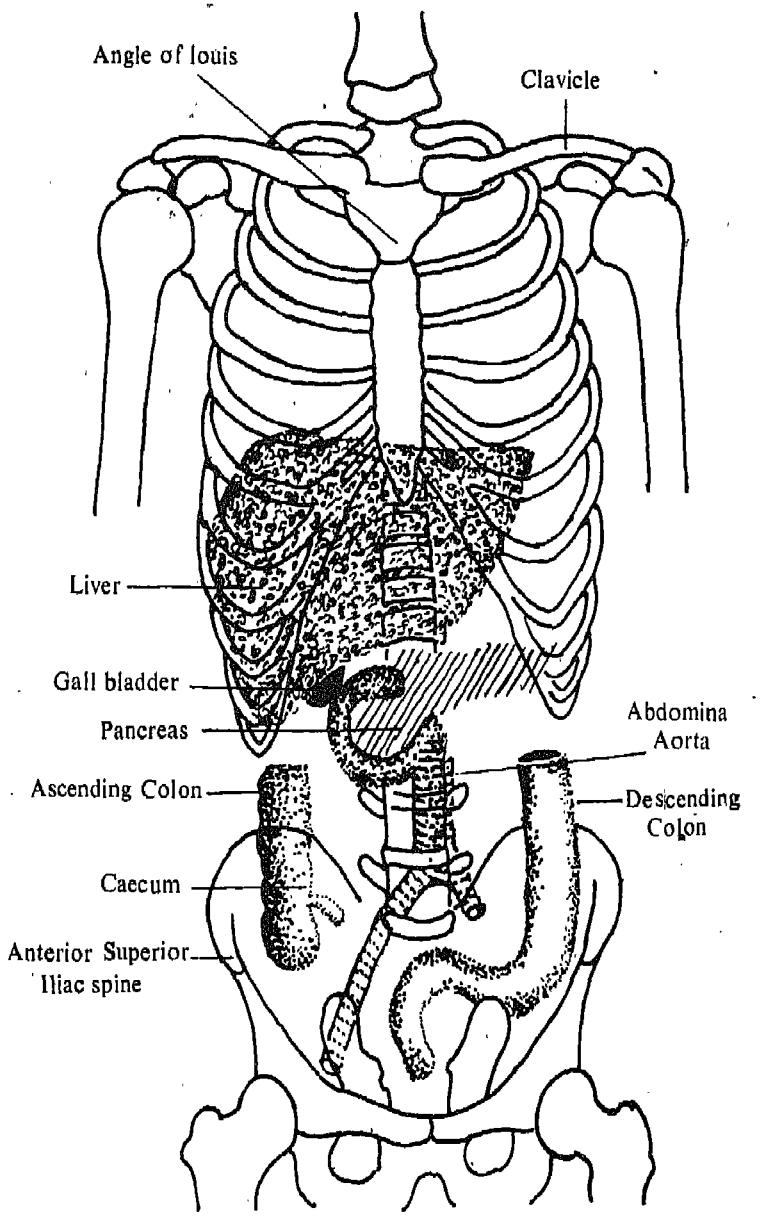

Fig. 30. THE TRUNK, SHOWING THE POSITION OF ORGANS IN RELATION TO THE ABDOMINAL WALL

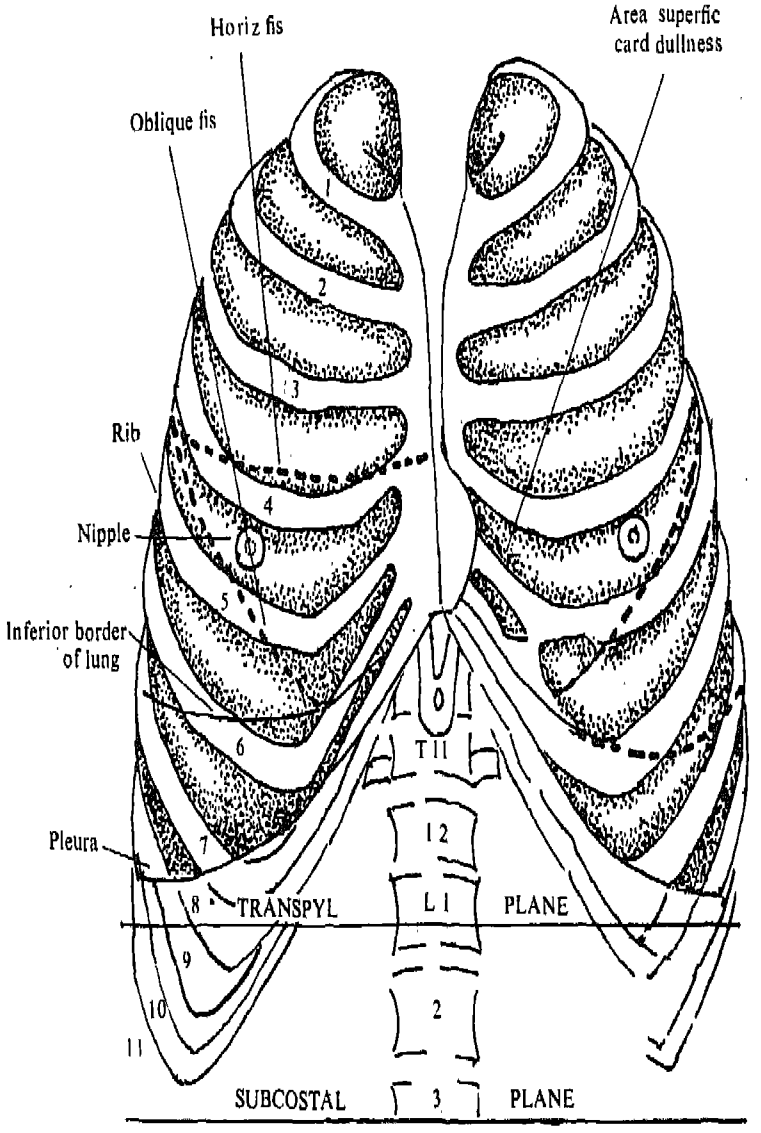

Fig. 31 LUNG AND PLEURA

downwards drawn from the left end of the fundus to the lower margin of the pylorus.

6.9 Uterus

Uterus lies in the lesser pelvis behind the bladder and infront of the rectum. In the empty state of the bladder it lies entiely in the lesser pelvis.

6.10 Urinary Bladder

Urinary bladder lies posterior to the pubic symphysis and lies entirely in the pelvis in its empty state. As it distends it raises above the pubic symphysis to the abdomen. Prostate gland lies behind the lower part of pubic symphysis.

6.11 Ureter

Ureter can be represented on the surface by a line drawn from a point on the transpyloric plane 5 cm from the median plane downwards and medially to the point 2 cm lateral to pubic symphysis. (Fig. 31)

1. [illegible]
2. Grant's Method of Anatomy
3. Grant's Atlas
4. Anatomy and Physiology for Nurses
   —By Evelyrie Pearce.
5. Elements of Human Anatomy, Physiology and Health Education
   —By Dr. Hari R. Dirasare
6. Cunningtram's Manual of Anatomy